SCIENCE ABSTRACTS.

Section A.—PHYSICS.

JUNE, 1928.

GENERAL PHYSICS.

1432. Density, Compressibility and Atomic Weight of Neon. G. P. Baxter and H. W. Starkweather. *Nat. Acad. Sci., Proc.* 14. *pp.* 50–57, *Jan.*, 1928.

The normal density of neon, purified chemically and afterwards by fractional adsorption, is 0·89990, this value giving 20·182 for the atomic weight. [See also Abstracts 1235 and 1236 (1927), and 1112 (1928).]

T. H. P.

1433. Compressibility and Pressure Coefficient of Resistance of Ten Elements. P. W. Bridgman. *Am. Acad., Proc.* 62. *pp.* 207–226, *Dec.*, 1927.

Compressibilities were measured with the lever piezometer for small specimens, and in cases in which the available material was pure enough to make it worth while the pressure coefficient of resistance was also determined. Any marked degree of impurity made values obtained for this last quantity theoretically valueless. The following elements were investigated, the compressibility of all of them, and the pressure coefficient of resistance of the first six, having been determined: Praesodymium, lanthanum, cerium, beryllium, barium, thorium, chromium, vanadium, phosphorus (red and black), sulphur. The compressibilities fall into line with the position of the elements in the periodic table. Black phosphorus seems to be the normal form; its $\Delta V/V_0$ falls more smoothly between Si and S than that of red phosphorus. Nothing can be said about Th except that $\Delta V/V_0$ is higher than for U. In the case of La, Ce and Pr, $\Delta V/V_0$ for Ce is higher than for La and Pr, though an intermediate value might be expected; $\Delta V/V_0$ is otherwise anomalous for Ce. The resistance phenomena under compression are not so simple; unlike that of most elements, the resistance of the low pressure modification of Ce and of Ba at high pressures increases under pressure. There are other anomalies, and the author has been led to think that a single type of mechanism is unable to explain the various behaviour of different metals.

H. N. A.

1434. Practical Method for the Measurement of Low Pressures. H. Teichmann. *Zeits. f. tech. Phys.* 9. 1. *pp.* 22–26, 1928.

Investigations upon the ionisation manometer by Dushman and

Found, and Simon [see Abstract 2409 (1924)] have established a direct proportionality between pressure and positive ionisation current. The present author now describes an arrangement using an ionisation manometer whereby pressures as low as 5×10^{-7} mm. may be determined within an accuracy of 15 %. The instrument is suitable for the control of pressures in vacuum operations but not for rapid pressure changes.

H. H. Ho.

1435. Construction and Standardisation of an Interferometer Pressure Gauge. J. J. Manley. *Phys. Soc., Proc.* 40. *pp.* 57–60; *Disc.*, 60–61, *Feb.*, 1928.

This paper deals with the application of a Michelson interferometer to the determination of gas pressures ranging from 0·0001 to 20 mm. of mercury. The construction of the instrument is fully described, as are also the methods used for standardising the registering micrometer screw and its graduated head. The gauge can be instantaneously set and the pressure which obtained at the moment of setting measured at leisure.

AUTHOR.

1436. Description of the Exhibits at the Eighteenth Annual Exhibition of the Physical and Optical Societies. Research Section. A. Ferguson. *Journ. Sci. Instruments,* 5. *pp.* 47–54, *Feb.,* 1928.

A large number of exhibits are briefly described, and among the subjects dealt with are an anatomical frame for optical tests on eyes; uses of ultra-violet light in textile analysis; progress in the production of alloy steels; an apparatus for measuring the velocity of reaction of coke with CO_2; a photoelectric rating machine for electric lamps; an X-ray camera of special design; an apparatus for high-frequency interruption of light by a piezoelectrical crystal; apparatus and instruments for ultra-violet work in microscopy, refractometry, and spectroscopy; a new form of high-range thermionic voltmeter; a reflex micrograph and a calorimeter for measuring the energy of detonation of high explosives. R. S. R.

1437. Description of the Exhibits at the Eighteenth Annual Exhibition of the Physical and Optical Societies. Meteorological Instruments. E. G. Bilham. *Journ. Sci. Instruments,* 5 *pp.* 74–75, *Feb.,* 1928.

The exhibits included (1) a large aneroid barometer incorporating a movement in which two groups of diaphragms operate on the opposite sides of a rocking-arm fulcrumed on a spring strut, the resulting rotational movement being transmitted by a lever-and-chain mechanism to the pointer spindle; (2) a barograph in which improved sensitivity and accuracy are obtained by the use of special diaphragms, thus giving increased control; and (3) a modified whirling hygrometer. R. S. R.

1438. Description of the Exhibits at the Eighteenth Annual Exhibition of the Physical and Optical Societies. Historical Exhibits. E. N. da C. Andrade. *Journ. Sci. Instruments,* 5. *pp.* 76–79, *Feb.,* 1928.

Two of the exhibits were designed to illustrate the early history of the air-pump and the balance; another exhibit dealt with the astrolabe and one with the early history of the gramophone. A collection of pictures and models illustrated the evolution of weighing-machines, pictures including photographs of ancient records touching on weighing and of certain modern types in which the primitive forms have survived with little change. R. S. R.

1439. Description of the Exhibits at the Eighteenth Annual Exhibition of the Physical and Optical Societies. Special Educational Apparatus. C. R. Darling. *Journ. Sci. Instruments,* 5. *pp.* 79–80, *Feb.,* 1928.

A description is given of several appliances shown for the first time. In Clarke's optical smoke-box the smoke is prevented from settling by agitating the air occasionally by means of a rubber bulb, and the elementary laws of optics can be well illustrated. Hansel's units for constructing apparatus were shown by the inventor. A " Cirscale " ammeter of good size, mounted in a glass case so as to display the working parts, was useful for class demonstration of its action and for quantitative work. A robust mirror galvanometer of good sensitivity was likely to be able to stand heavy wear and a certain amount of rough treatment. R. S. R.

1440. Apparatus for Determining, in Small Volumes of Fluid, the Osmotic Pressure of Colloids. E. B. Verney. *Journ. Sci. Instruments,* 5. *pp.* 97–100, *March,* 1928.

A form of apparatus, similar to that devised by Govaerts, was employed to determine the osmotic pressures of liquids containing proteins. The apparatus was capable of being immersed in a thermostat, and the semipermeable membrane was a material known as " Cellophane." F. J. B.

1441. Machine with Epicycloidal Motion for Grinding Lenses. C. Dévé. *Comptes Rendus,* 186. *pp.* 567–569, *Feb.* 27, 1928.

Describes a simple mechanism whereby the piece of glass being worked rotates about its centre, which describes an epicycloid in space, on a rotating table. Surfaces of good form and polish are rapidly obtained by its use. W. G. B.

1442. Quartz Helical Springs. H. D. H. Drane. *Phil. Mag.* 5. *pp.* 559–560, *March,* 1928.

Gives details of the method of preparing from quartz fibre very sensitive helical springs of uniform curvature. A spring with twenty turns, 0·88 cm. diameter, extended at the rate of $0 \cdot 33 \times 10^5$ cm. per gm., the diameter of the fibre being $1 \cdot 65 \times 10^{-3}$ cm. W. H. GE.

1443. Molecular Orientation at Surfaces of Solids. Part I. Measurement of Contact Angle and the Work of Adhesion of Organic Substances for Water. A. H. Nietz. *Eastman Kodak Co. Research Lab. Comm. No.* 323. *J. Phys. Chem.* 32. *pp.* 255–260, *Feb.,* 1928.

Compares two methods of measuring the contact angle between liquids and solids, the Ablett cylinder and the plate methods; the first proved in its existing form to be uncertain, and the main experiments have been made by a form of the plate method which is described. The work done in separating a solid from a liquid surface per sq. cm. is $W = T_L + T_S + T_{LS}$, where T_L and T_S are the free energies of the liquid and solid surfaces, and T_{LS} is that of the interface which has disappeared; these free energies also measure the surface tensions. If θ is the contact angle between the liquid and the solid, $W = T_{LA}(1 + \cos\theta)$. Measurements have been made on about seventy organic solids, and tables give values of the contact angles, the percentage reduction of the surface tension of water caused by the presence of the solid, the percentage reduction of the contact angle of pure paraffin and the work of adhesion; notes are given on the spreading of the solid on the surface of the liquid. The results appear to be in accord with others on liquids and solids and with the theories of Harkins and Langmuir. The effect of the conditions during crystallisation on the orientation of the molecules in the layer of solid on the glass plate which was employed was studied; heat and humidity have a very large influence on the nature of the surface formed. H. N. A.

1444. Studies in Adhesion. Part II. W. Hardy and Millicent Nottage. *Roy. Soc., Proc.* 118. *pp.* 209–229, *March* 1, 1928.

An admirable summary of previous work on adhesion is given by McBain and Lee [see Abstract 1615 (1927)]. In the first part of the present paper the results of measurements of the tensile strength of a joint between a cylinder and a plate are described, such measurements having been made with difficulty owing to the sensitiveness of the joint to vibrations. Experimental details are included. The adhesion value of myristic acid is greater than that of eicosane and of steel greater than that of copper. An insensible film of contaminant at one interface leads to the following: (1) When one surface only is contaminated, the break occurs at the contaminated surface when the adhesion of the contaminant is weaker than that of the lubricant, and at the uncontaminated surface when the lubricant is the weaker adhesive; (2) when both surfaces are contaminated, the ordinary relation between the position of the break and the adhesion values of the solids is not interfered with; (3) a weak contaminant lowers the adhesion value, and to its own value in one case. A strong contaminant raises the adhesion, though the surface of break may not be near the contaminated but near the uncontaminated surface. The second part of the paper considers steady values of the adhesion and their relations to temperature, nature of enclosing solids, molecular weight and pressure, the third part being devoted to tangential pull. H. H. Ho.

1445. General Equations of Elastic Surfaces. L. Roy. *Comptes Rendus,* 186. *pp.* 480–483, *Feb.* 20, 1928.

Applies moving axes and energy to obtain the general equations of elastic surfaces. W. G. B.

1446. Tensions Produced in Elastic Solids by Variation of Temperature. D. Bonvicini. *Ann. R. Scuola Ing., Padova,* 3. *pp.* 44–46, *March,* 1927.

The general case of any elastic solid which undergoes a variation of temperature is treated mathematically by application of the theorem of virtual works. Another example dealt with is an isotropic elastic beam in the form of an arch of rectangular cross-section rigidly fixed at the extremities. J. J. S.

1447. Extension Investigations on Smoked Rubber Sheet. P. Rosband and E. Schmidt. *Zeits. f. tech. Phys.* 9. 3. *pp.* 98–106, 1928.

The effect of velocity of extension and temperature on the stretching and breaking of smoked sheet are investigated. It is pointed out that much work has already been done on the extension or stretching of rubber since the work of J. R. Katz, who found that the illumination of stretched rubber with monochromatic Röntgen rays gave rise to interference bands which increase in clearness with increase in the degree of stretching. The authors state, however, that a systematic description of the effect of the two important factors mentioned was so far not to be found. The results given are for temperatures lying between — 185° C. and 80° C. and for extension velocities between quite small values to about 50 %/sec. A model is given which allows one to read the strengths for values lying between the temperatures and extension velocities indicated. J. K.

1448. Statical Hysteresis in Cyles of Equal Load Range. G. H. Keulegan. *Bureau of Standards, Technol. Papers, No.* 365. *pp.* 379–387, 1928.

The present paper deals with an investigation made for the purpose of ascertaining the influence of the extreme loads on the energy hysteresis loss in the cycles of equal load range during the flexure of an Armco iron bar. It is an extension of work reported earlier [see Abstract 877 (1927)]. The flexure of the bar is considered for the case where one end of the bar is clamped and the other end loaded. Since in Armco iron the hereditary hysteresis is negligible in comparison with the statical hysteresis, the results of the experiment apply mainly to statical hysteresis. Cycles of small extreme loads only are considered, and the conclusion derived from the result of the experiments is to the effect that the energy loss due to statical hysteresis in cycles of equal load range is independent of the extreme loads. AUTHOR.

1449. Oscillations in a Bridge Caused by the Passage of a Locomotive. C. E. Inglis. *Roy. Soc., Proc.* 118. *pp.* 60–96, *March* 1, 1928.

The problem is simplified by considering the bridge as a simple girder or rod, supported at both ends, and the locomotive as a concentrated moving mass producing a pulsating force on the bridge, which has its origin in the balance weights attached to the driving wheels. The oscillations are greatest when the period of pulsation coincides with the natural period of vibration of the bridge, but are in all cases reduced in magnitude by damping. The mathematical treatment leads to results which agree well with experimental data obtained on many actual bridges, and on a reduced scale experimental bridge and moving vibrator. In certain cases, however, complications are introduced owing to the action of the springs of the locomotive. H. N. A.

1450. Three-Dimensional Stress Distribution in the Plastic State. W. Jenne. *Zeits. f. angew. Math. u. Mechanik,* 8. *pp.* 18–44, *Feb.,* 1928.

On the assumption that the deformation velocity tensor depends linearly upon the "reduced" stress tensor (*i.e.*, the stress tensor minus the hydrostatic pressure, which is the average of the principal stresses), the differential equations for plastic deformation are obtained and also some compatibility conditions analogous to those of the theory of elasticity. The condition for a plastic state is taken in v. Mises' form, that the sum of the squares of the three maximum shear stresses is constant. Cases where the stress is the same in a set of parallel planes, in a set of planes normal to a curve, and that of axial symmetry are discussed, but, except in the first, it seems impossible to satisfy at the same time the differential equations and the equations of compatibility, at least with a linear relationship between the two tensors. W. G. B.

1451. Viscosity of Mercury Under Pressure. P. W. Bridgman. *Am. Acad., Proc.* 62. *pp.* 187–206, *Dec.*, 1927.

The pressure varied over the range up to 12,000 kg./cm.^{2}, the measurements being made at 30° C. and 75° C. The mercury was contained in two copper reservoirs connected by a copper capillary; as the mercury amalgamates to a slight extent with the copper, the sides of the tube are wetted. The pressure chamber could be rotated back and forth through fixed angles, the mercury running from one reservoir to the other while the apparatus was inclined to the horizontal at about 11°. The timing of the flow was measured by methods depending on electrical contacts made with the surface of the mercury. A very complete account is given of the corrections which must be applied. The final results show that the viscosity at 30° C. and 75° C. increases about 33 % for an increase of pressure of 12,000 kg./cm.^{2}. This is small in comparison with the increase observed with other liquids. A. A. D.

1452. Dynamic and Kinematic Viscosity Units. M. Jakob. *Zeits. f. tech. Phys.* 9. 1. *pp.* 21–22, 1928.

The kinematic viscosity number ν is defined as viscosity η/density ρ and has dimensions L^2T^{-1}, containing, therefore, neither mass nor force. η itself is reserved for the dynamic viscosity number, having dimensions including force or mass. The author suggests the name " Stokes " for the kinematic viscosity unit. H. H. Ho.

1453. Variations in the Surface Tensions of Solutions. S. L. Bigelow and E. R. Washburn. *J. Phys. Chem.* 32. *pp.* 321–353, *March*, 1928.

Confirmation is furnished of the decrease of surface tension with time observed by previous workers with solutions of sodium oleate, sodium glycocholate, and glycerol, and the same phenomenon is found to occur with solutions of various other substances—for instance, phenol, resorcinol, pyrogallol, propionic acid, valeric acid, and succinic acid. Experimental evidence is advanced in support of the theory that this phenomenon is caused by the adsorption of the organic solute at the glass-solution interface as well as at the vapour-solution interface. Contrary to the opinion of du Noüy (*J. Exp. Med.* 35. pp. 575, 707; 36. p. 113, 1922), the phenomenon may be observed and adequately studied by the capillary rise method, and several of the results thus obtained could hardly be noted if any dynamic method of measuring surface tension were employed. Solutions of certain esters and alcohols show time increases of surface tension, which rises to a maximum. The fresh surface formed by agitation displays the original minimum value, from which another rise begins at once. Investigation of these changes with ethyl acetate solutions shows that the cause lies in evaporation and diffusion of small proportions of the ester through the capillary tubes of the apparatus. Methods are given for measuring the very small amount of solute necessary to produce extensive lowering of the surface tension, for estimating the rates of diffusion to and from surfaces, for estimating the concentration at the surface of a meniscus, and for estimating the degree of hydrolysis of a solution of an ester. T. H. P.

1454. Surface Tension and Structure of the Surface of Aqueous Ammonia Solutions. O. K. Rice. *J. Phys. Chem.* 32. *pp.* 583–592, *April*, 1928.

The results are given of measurements of the surface tension of aqueous ammonia solutions over a range of concentrations from 0 to 14 moles per litre, use being made of a capillary tube of fairly wide bore placed at an angle so as to increase the sensitiveness fivefold. The adsorption, defined in several different ways, of the ammonia at the surface of the solution is calculated, the results indicating that, even at the highest concentrations used, there was not enough ammonia molecules at the surface to fill a monomolecular layer. The work, W_x, done on a mole of ammonia when it is brought from the body of the solution to a distance x from the surface is balanced by the change in partial free energy due to that increased concentration of ammonia at the point x. Consideration of these relations with the help of the partial pressure curve for ammonia shows that $\int_0^\infty W_x dx$ is a linear, slightly decreasing (in magnitude, sign being disregarded) function of the concentration in the body of the solution, for the higher concentrations used. By extrapolation of this linear relationship to infinite dilution and by use of the laws of dilute solutions, it is estimated that the average adsorbed molecule is about 10^{-8} cm. from the surface. T. H. P.

1455. Explanation of a So-Called " Intertraction " Phenomenon. N. K. Adam. *Roy. Soc., Proc.* 118. *pp.* 262–263, *March* 1, 1928.

The paper describes tests undertaken in reply to criticisms by A. E. Wright [see Abstract 1963 (1927)] of previous papers. A photograph is reproduced of fine streamers formed when a slow upward current of water impinges on a disc of filter paper soaked in dye solution. Variations of the rate of flow produced slight alterations in the appearance of the streamers but never a uniform cloud. Glazed and waxed papers also produced streamers, but a slow current of coloured liquid impinging on a plate in the surface did not. Drops of coloured liquid emerging from a hole in a glass plate did not produce fine streamers, but a few rather coarse streamers appeared when coloured liquid was placed in a tin with a number of small holes in the bottom. The streamers in the case of the filter paper are ascribed to the fibres of the paper. R. S. R.

1456. Determination of the Boundary Layer. K. Scholler. *Zeits. f. tech. Phys.* 9. 1. *pp.* 19–21, 1928.

It has been physically established that the first and second derivatives of the boundary layer velocity are in linear relationship, and the velocity curve has in consequence been found within the boundary layer. The subtangent at the initial point of this curve is shown to be a suitable measure of the thickness of the boundary layer, and so furnishes a graphical method for its determination at every point of the contour. H. H. Ho.

1457. Additional Notes on the Oscillations of a Liquid in Communicating Vessels. R. Mazet. *Accad. Lincei, Atti,* 6. *pp.* 32–37, *July,* 1927.

Extends results to three-dimensional motion. W. G. B.

1458. Lines of Flow and Lines of Current. A. Masotti. *Accad. Lincei, Atti,* 6. *pp.* 401–403, *Nov.* 20, 1927.

In a non-stationary movement of fluid we have to distinguish between lines of flow (the vectorial lines of velocity, which always constitute a congruence) and the lines of current (the trajectories of the liquid particles, which constitute a complex). In stationary movement and, more generally, when the orientation of the velocity is at every point invariable with time, the two systems coincide. Discusses the orders of contact of these two sets of lines. A. D.

1459. Rapidly Converging Graphical Solutions of Stream Problems by Integral Equations. F. Weinig. *Zeits. f. tech. Phys.* 9. 1. *pp.* 39–43, 1928. *Paper read before the Deut. Physiker u. Mathematikertag, Kissingen,* 1927.

The potential stream about given bodies is found by means of source-systems which are determined by the solution of integral equations. Rapid graphical methods are now derived for the solution of these equations, and great accuracy is claimed for them. H. H. Ho.

1460. Certain Steady Motions of Incompressible Viscous Liquids. A. Rosenblatt. *Comptes Rendus,* 186. *pp.* 678–680, *March* 12, 1928.

Demonstrates the theorems: (1) In the steady plane motion of an incompressible viscous liquid, if the force is everywhere normal to the lines of flow, then it is possible to choose the parameter for the lines orthogonal to the lines of flow so that the curves ψ = const. and ϕ = const. give a transformation of the plane which conserves areas. (2) In a steady motion of space, if the lines of flow form a normal congruence, and if the force is everywhere normal to the lines of flow, one can choose the parameter of the family of normal surfaces so that the volume of a tube of flow between two surfaces of the family, ϕ_1 and ϕ_2, is proportional to $\phi_2 - \phi_1$. W. G. B

1461. Brownian Waves of Thin Laminæ and Filaments in Myelin Formations. Nageotte. *Comptes Rendus,* 186. *pp.* 741–743, *March* 19, 1928.

The elementary laminæ which, by their juxtaposition, constitute myelin formations do not reflect light so long as they are not dispersed except at the limiting layers to which these formations owe the reflecting power of their surfaces. The reflections of tube surfaces with thick walls are much more luminous than those of drops with thin walls, and the present paper endeavours to derive the mechanism of these phenomena. Various types of drops are examined and the surface undulations discussed. H. H. Ho.

1462. Theory of Discontinuous Fluid Motion and Facts. L. Prandtl. *Phys. Zeits.* 29. *pp.* 118–119, *Feb.* 15, 1928.

Remarks on Ahlborn's paper [see Abstract 1130 (1928)]. Attention is called to forthcoming articles in the *Jahrbuch der Wissenschaftlichen Gesellschaft für Luftfahrt* and in the volume on mechanics of the *Physiklehrbuch Müller-Pouillet*, where it is shown that for liquids of small viscosity the discontinuity and the "Grenzschicht" theories are so interconnected, and agreement between theory and fact so good, that further experimental work is unnecessary. W. G. B.

1463. Development of Vector Integrators for the Mechanical Solution of Potential and Vortex Problems. H. Föttinger. *Zeits. f. tech. Phys.* 9. 1. *pp.* 26–39, 1928. *Paper read before the Deut. Physiker u. Mathematikertag, Kissingen*, 1927.

This very comprehensive paper discusses methods for solving by elementary and approximate means those boundary problems in potential and vortex theories which hitherto have only been treated by difficult methods of analysis or have been abandoned as insoluble. In particular, the Rankine method has been systematically explored in connection with vortices and surface and volume displacements, with a view to its application for the approximate solution of the integral equation. In the case of singularities, rules have been derived on kinematic grounds for the first and succeeding approximations. This work has led *via* graphical-numerical methods to the vector integrator for which special and universal machines have been devised. The determination of hollow space forms from previously chosen physical relationships has been achieved. The paper contains twenty-one illustrations and diagrams. H. H. Ho.

1464. Wave Resistance. T. H. Havelock. *Roy. Soc., Proc.* 118. *pp.* 24–33, *March* 1, 1928.

Gives more direct proofs of expressions for wave resistance used in previous calculations; these are generalised, so that the wave resistance for any set of doublets in any positions or directions in a uniform stream can be obtained. The expressions can be applied to bodies either wholly or with certain limitations partially submerged. Refers to Lamb's method of calculating wave resistance, which deals with a single doublet, to which a submerged body is equivalent to a first approximation; he carries out the calculation by analysing first the surface distribution of velocity potential, or in effect analysing the wave pattern. The author avoids this intermediate analysis by direct application of the Fourier double-integral theorem in two dimensions; this simplifies the extension of the calculation to any distribution of doublets in any positions and directions. The paper deals mathematically with two-dimensional motion, the horizontal doublet, horizontal doublet in vertical plane, doublets with their axis in any directions, two doublets in any positions, and a horizontal doublet in a stream of finite depth; in the other cases the depth is taken as infinite. H. N. A.

1465. Effect of Compressibility on the Lift of an Aerofoil. H. Glauert. *Roy. Soc., Proc.* 118. *pp.* 113–119, *March* 1, 1928.

An attempt is now made to estimate theoretically the effect of compressibility on the lift of an aerofoil in two-dimensional motion, and to indicate the nature of the variation which may be anticipated in the curve of lift coefficient against angle of incidence. A similar calculation cannot yet be made for the drag of the aerofoil, but on general grounds the drag coefficient may be anticipated to rise at an increasing rate until the velocity of sound is reached, and that above this speed the drag coefficient will decrease again, remaining, however, higher than at low speeds. The general conclusions are: (1) As the speed increases from zero to $0 \cdot 6a$, the slope of the lift curve increases according to the factor $(1 - v^2/a^2)^{-\frac{1}{2}}$, and the no-lift angle is unaltered, v being the velocity of the undisturbed stream and a a constant; (2) between $v = 0 \cdot 6a$ and $v = a$ the lift decreases, but the critical speed at which the lift begins to fall rapidly depends on the shape of the aerofoil. The rapid decrease probably shows itself first at the higher lift coefficients. H. H. Ho.

1466. Vortices behind Aerofoil Sections and Rotating Cylinders. E. Tyler. *Phil. Mag.* 5. *pp.* 449–463, *March*, 1928.

Experimental determination of the frequency of formation of vortices behind obstacles of different sections, primarily aerofoil sections inclined at different angles of incidence to the wind-stream. Tracing out the paths of the centres of the vortices formed behind stationary and rotating obstacles (*e.g.*, rotating cylinder and stationary aerofoils). A. D.

1467. Some Cases of Instability in Fluid Motion. H. Jeffreys. *Roy. Soc., Proc.* 118. *pp.* 195–208, *March* 1, 1928.

Recently the author obtained a numerical solution of some problems concerning the stability of a layer of incompressible fluid when the temperature decreases upwards, the results depending on the solution of the sixth-order equation $(d^2/d\zeta^2 - a^2)^3 z = -\lambda a^2 z$, which was obtained by L. F. Richardson's method of finite differences. A solution is now obtained by assuming a trigonometric series for $d^6 z/d\zeta^6$ and then obtaining forms for lower derivatives and for z itself by integration. The constants introduced by the integrations give a polynomial of the fifth degree in z, while the trigonometric portion gives a series converging very rapidly. Various problems are then considered: that of Rayleigh, that of a rigid conducting boundary at base and a non-conducting free surface at top, the effect of a current, and the effect of a general rotation. It is shown that the effect of heating, from the bottom, an atmosphere originally perfectly stagnant might be to give first disturbances of the nature of tornadoes, which with increasing turbulence would spread out and produce movements on a larger horizontal scale comparable with the height of the atmosphere or with tropical cyclones and thunderstorms. H. H. Ho.

1468. Foundations of Dynamics. The Fifth Dimension. A. Proca. *Comptes Rendus*, 186. *pp.* 739–741, *March* 19, 1928.

If it be admitted that mass is a new variable independent of the dynamical problem, then for complete definition it is necessary to introduce also the variable conjugate to the mass [see also Abstract 845 (1928)]. If space-time suffices for the study of kinematics, then it is shown that the complete conception of dynamics must be obtained in five-dimensional space, and the author accordingly gives an interpretation of the fifth dimension, whereby it is found that the new coordinate λ is an angular variable whose period is an integral multiple of the wave-length of the de Broglie waves. H. H. Ho.

1469. Relativistic Mechanics: the Rotation of the Earth. G. Thomsen. *Accad. Lincei, Atti*, 6. *pp.* 37–43, *July*, 1927.

Applies general results formerly obtained [see Abstract 22 (1928)] to the problem of the rotation of the earth. Whereas on the classical theory the precession of the earth has two components (the one due to the attraction of the sun, the other to that of the moon, the latter being twice the former), in the relativistic case it has three components, the precession of Fokker-Schouten, one due to the sun and one due to the moon. Of these three the first amounts to $\frac{1}{2500}$ of the whole. A. D.

1470. Deformations of the Element of a Belt in the Neighbourhood of Contact with the Pulley. Swyngedauw. *Comptes Rendus,* 186. *pp.* 569–571, *Feb.* 27, 1928.

Stroboscopic observations have shown that the outer surface of the belt increases its speed for 4 or 5 cm. before, and 2 cm. after, the point of contact. Assuming, as is probable, that a section normal to the line of motion remains plane, the way in which the belt passes from the straight to the curve is deduced, and also the amount of relative slip between belt and pulley just after contact. W. G. B.

1471. Equilibrium of Heavy Masses Subjected to Under-Pressure Applied to the Stability of Dams and Earth-Slopes. E. Baticle. *Comptes Rendus,* 186. *pp.* 571–574, *Feb.* 27, 1928.

It is shown that the possibility of an upward pressure (as, for instance, that due to water oozing into cracks) at the base of a dam of triangular section increases the base necessary for stability (absence of tensile stress) by the factor $\sqrt{2}$, and for a granular mass it reduces very considerably the angle of repose. W. G. B.

1472. Equilibrium of Heavy Masses Subjected to Under-Pressure, Applied to the Stability of Dams and Earth-Slopes. J. Mesnager. *Comptes Rendus,* 186. *pp.* 628–630, *March* 5, 1928.

In addition to the effects pointed out by Baticle [see preceding Abstract] there is also the fact that, since the specific gravity of masonry or concrete is not much greater than 2, the apparent weight of a dam of triangular section subjected to hydrostatic pressure below will be but a small fraction of its total weight, and so the frictional forces preventing the structure from sliding will be very small. This further emphasises the need of an impervious water face. In a note **A. Mesnager** comments upon the danger, from the above considerations, of building solid dams with horizontal courses, and even more, of using successive, and necessarily horizontal, layers of liquid concrete. W. G. B.

1473. Crystal Structure of Iodoform. J. F. Wood. *Univ. of Durham Phil. Soc., Proc.* 7. 4. *pp.* 168–171, 1926–1927.

Laue photographs show that the class is C_6, D_6 or C_{6h}; X-ray reflection and rotation photographs indicate two molecules per unit cell; 6, 12, 12 asymmetric molecules respectively are required to produce the symmetry of the above classes, so the symmetry of the iodoform molecule must be three- or six-fold; on chemical grounds six-fold symmetry may be ruled out, so that the class is C_6; $a = 6 \cdot 92$ Å.; $c = 7 \cdot 69$ Å. The observed spacing of (0001) is half the calculated value, which implies that the space group has screw axes parallel to the C axis; this leads to the space group C_6^6, the molecule of iodoform having a trigonal axis. This means that the atoms must lie in one line, which is chemically unlikely, or the molecule must be a tetrahedron with the C inside and the H and I atoms at the corners. Two alternative arrangements of the molecules are worked out, the latter of which is regarded as the more satisfactory; this is illustrated by diagrams, and gives a fairly satisfactory fit, though the iodine does not quite fill the gap between the carbon and hydrogen of neighbouring molecules. H. N. A.

1474. Symmetry of Crystals of Pentaerythrite. H. Seifert. *Preuss. Akad. Wiss. Berlin, Ber.* 34. *pp.* 289–293, 1927.

This substance, $C(CH_2OH)_4$, has for some time aroused considerable interest on account of a suggestion of Weissenberg that its molecule may not be tetrahedral or quasitetrahedral, but pyramidal with the four (CH_2OH) groups at the corners of the base of a pyramid and the remaining C at the apex. Partly on crystallographic grounds and partly from the Laue diagram, the author reduces the possible classes to the three, C_{4h}, C_4 and S_4. Considering the asymmetrical etch figures and striæ produced on the surfaces, class C_4 is excluded, and C_{4h} falls out owing to the form of the etch figures produced in basal cleavage plates. It follows that the symmetry class is S_4, sphenoidal tetartohedral. A complete investigation of the etch figures shows that there are actually two interpenetrating bisphenoidal twins in each crystal, the two individuals being symmetrical with respect to the base. The four CH_2OH groups are arranged round the C atom at the corners of a bisphenoid, resembling a tetrahedron. Of the two S_4 space groups only S_4^2 is involved. There are two molecules in the unit cell; the directly attached H atoms of these molecules are arranged in a peculiar manner, which the author considers will account for the optical anomalies of the substance. H. N. A.

1475. Structure of Silver Chlorate. A. Ferrari and C. G. Fontana. *Accad. Lincei, Atti,* 6. *pp.* 312–314, *Nov.* 6, 1927.

The results of X-ray measurements show that the lattice of silver chlorate exhibits a tetragonal cell containing eight molecules: $a = 8 \cdot 48$ Å. and $c = 7 \cdot 91$ Å. The calculated density is 4·46, the observed value being 4·44. T. H. P.

1476. Crystalline Structure of the Double Chloride of Cadmium and Cæsium, $CsCdCl_3$. A. Ferrari and A. Baroni. *Accad. Lincei, Atti,* 6. *pp.* 418–422, *Nov.,* 1927.

The results of X-ray measurements indicate that cæsium cadmium chloride has a monometric lattice, the elementary cell of which contains 1 molecule and has the side 5·20 Å. The $CdCl_3^-$ ion exhibits global dimensions less than the sum of those of the component ions, this property being apparently general for complex ions. The identity in structure between $CsCdCl_3$ and $CsHgCl_3$ furnishes a further example of the crystallographic analogy between cadmium and mercury. T. H. P.

1477. X-Ray Analysis and Crystalline Structure of Cadmium-Silver Alloys. Part I. G. Natta and M. Freri. *Accad. Lincei, Atti,* 6. *pp.* 422–428, *Nov.* 20, 1927.

For the α-phase of the system cadmium-silver, representing solid solutions of cadmium (up to 44 %) in silver, the length of the side of the elementary cell varies linearly with the composition, its value increasing from 4·07 Å. for pure silver to 4·14 Å. for the alloy containing 31 atom. per cent. of cadmium. The β-phase, corresponding with the compound

AgCd and with solid solutions of cadmium in this compound, yields photograms of quite different aspect, the few lines present being readily arranged according to a cube-centred lattice of the cadmium chloride type; the calculated densities agree well with the experimental values. The transformation observed by Petrenko and Federow [see Abstracts 968 and 1614 (1911)] in the compound AgCd at 460°, and regarded by them as a decomposition of the unstable β-alloy into the neighbouring α- and γ-phases, actually consists of a polymorphous change, since all the lines of the photograms conform well with a hexagonal or rhombohedral lattice with the axial ratio 1·62; the side of the cell is $a = 3 \cdot 01$ Å., and the elementary cell contains 1 molecule of AgCd, the calculated density being 9·57. T. H. P.

1478. X-Ray Analysis and Crystalline Structure of Cadmium-Silver Alloys. Part II. G. Natta and M. Freri. *Accad. Lincei, Atti*, 6. *pp.* 505–511, *Dec.* 4, 1927.

The β'-phase of these alloys, obtained when the β-phase is reheated below 480°, is converted into a mixture of crystals of the α- and γ-phases when reheated below 200°. This change takes place only with solid solutions of silver in the compound AgCd, and not with those of cadmium in this compound or with alloys still richer in cadmium. The γ-phase of the system, which exhibits close structural analogy to the γ-phase of the brasses, has a cubic elementary cell of side $a = 9 \cdot 99$ Å., containing 52 atoms, the calculated density for the alloy with 64·1 atom. per cent. of cadmium being 9·59; the hypothetical chemical compound constituting this phase may be given the formula Ag_5Cd_8. The δ- and ϵ-phases, comprising alloys with 67 to beyond 90 % of cadmium, yield photograms of the same appearance, the lines corresponding with a compact, hexagonal structure having the axial ratio $c : a = 1 \cdot 58$. The η-phase has the same crystalline structure as cadmium itself and is composed of solid solutions of silver in the cadmium lattice. T. H. P.

1479. Crystal Structure of Potassium. E. Posnjak. *J. Phys. Chem.* 32. *pp.* 354–359, *March*, 1928.

Contrary to former statements, normal diffraction effects are obtained when potassium is submitted at room-temperature to X-ray examination by the usual powder method. The general scattering and no definite diffraction observed in the earlier experiments are regarded as due to the formation of films on the potassium by moisture, oxidation, or interaction with the glass. The data now available indicate that potassium crystallises in the body-centred cubic lattice form, the length of the edge of the unit cube containing two atoms of potassium being 5·333 ± 0·005 Å. and the calculated density 0·851. Redeterminations with sodium and lithium give 4·30 and 3·51 Å. respectively for the lengths of the cube edges, in agreement with earlier results. T. H. P.

1480. Deformation of Crystals of β-Brass. G. I. Taylor. *Roy. Soc., Proc.* 118. *pp.* 1–24, *March* 1, 1928.

Iron crystallises in body-centred cubes, and in a previous paper the author and Miss Elam have showed that slip does not occur on a definite crystallographic plane, as in other metals which have been investigated, all of which crystallise in face-centred cubes. The only other metal available for test crystallising in body-centred cubes is β-brass, two strips of which containing some large crystals, up to 5 cm. long, have been prepared for the author by Tamura. The numbers of copper and zinc atoms in the material are approximately equal, and compression and tensile tests have been carried out on specimens ground with different orientations with respect to the crystal axes. It was found that within a certain range of orientations the behaviour is similar to that of iron crystals, but in another range slip occurs on a definite crystal plane of type $\{110\}$. The conditions governing this are investigated; the determining cause is the variation in resistance to shear which occurs as the plane of slip rotates about the direction of slip. Resistance to shear is least when the plane of slip coincides with a $\{110\}$ plane, and there is a discontinuity in the rate of change of shear strength at this point. This property is also illustrated by the hexagonal rod model used for iron by the author and Miss Elam, and by Hume Rothery's model. In β-brass resistance to slipping in one direction on a given plane is not the same as for the opposite direction; this is to be expected from crystallographic symmetry, but was not observed with α-iron. H. N. A.

1481. Recrystallisation of Pure Aluminium. E. Schmid and G. Wassermann. *Zeits. f. tech. Phys.* 9. 3. *pp.* 106–109, 1928.

A study by X-ray photographic methods of the recrystallisation of pure (99·95 %) aluminium wire. On heating, the texture of these very pure specimens is not only maintained, but if the temperature is over 500° C. there is a considerable increase in the definition of the lines in the Debye-Scherrer photographs. These results are in contrast with those for commercial aluminium or copper wires. W. H. Ge.

1482. Influence of the Electric and Magnetic Field on the Crystallisation of Sub-Cooled Liquids. W. Kondoguri. *Zeits. f. Phys.* 47. 7–8. *pp.* 589–601, 1928.

It is an established fact that under the action of the electric and magnetic field the number of crystallisation centres of sub-cooled piperin and salol is considerably increased. The author's investigations led him to the following conclusions: (1) Under the influence of radium and also of the electric and magnetic field the rapidity in the increase of the number of crystallisation centres gradually diminishes, the sub-cooled liquid having most probably reached the saturation stage. It was found that on increasing the tension of the electric field the saturation is disturbed and the number of crystallisation centres again rises and approaches a higher limit. The action of radium and of the magnetic field has not yet been investigated in this respect. (2) The initial rapidity in the increase of the number of crystallisation centres and its maximum increment at saturation point are approximately proportional to the tension of the electric field. (3) The action of radium on salol produced a modification of the phenomenon, which differs widely from the normal development of the effect and has so far eluded explanation. Numerous tables and curves are given. E. F.

1483. New Examples of Mixed Crystals. Part II. Barium Sulphate and Potassium Permanganate. H. G. Grimm and G. Wagner. *Zeits. f. phys. Chem.* 132. 1–2. *pp.* 131–148, *Feb.*, 1928.

Barium sulphate and potassium permanganate form a series of mixed crystals containing up to 60 mols. per cent. $KMnO_4$ at 500, when the former is precipitated from concentrated solutions of the latter. Beyond 40 % these crystals are unstable and often break up spontaneously; in contact with water the stability is limited to 8 mols. per cent., but inside this range the mixed crystals are very stable towards reducing agents such as HCl, HNO_2, H_2SO_3. Qualitative experiments have indicated the existence of mixed crystals of the following types:—

$SrSO_4$	$BaSeO_4$	$SrSeO_4$	$BaCrO_4$	$BaSO_4$	KBF_4
$KMnO_4$	$KMnO_4$	$KMnO_4$	$KMnO_4$	KBF_4	$KMnO_4$

[See Abstract 470 (1925).] T. M. L.

1484. Enhancement Principle in X-Ray Photographs. W. H. Bragg. *Nature*, 121. *pp.* 327–329, *March* 3, 1928.

Directs attention to, and explains, the enhancement of certain groups of spots in the X-ray rotation photographs of crystals. This enhancement results from the superposition of effects due to different periodicities in the crystal structure. The principle is illustrated by reference to the work of W. L. Bragg on silicates [see Abstracts 24 and 25 (1928)], Müller on long-chain compounds [see Abstract 1993 (1927)], Astbury on acetyl-acetones [Abstract 38 (1927)], and by a discussion of rotation photographs of anthracene and naphthalene. H. R. R.

1485. Infra-Red Proper Vibrations of Binary Oxides, BeO, MgO, CaO, ZnO. Light Absorptions by Zapon Varnish. Sibylle Tolksdorf. *Zeits. f. phys. Chem.* 132. 3–4. *pp.* 161–184, *March*, 1928.

The whole lattice may vibrate as a continuum, and the particles may vibrate with respect to one another. When the particles are charged, an electromagnetic wave of a frequency corresponding to such a proper vibration may excite a resonance vibration, provided that the electric moment of the crystal differ from zero; if the movement be zero, the vibrations will optically be inactive, but will affect the specific heat. The author examines the oxides MgO and CaO (face-centred cubes of rock-salt type), and ZnO and BeO (hexagonal of the wurtzit type), the proper vibrations of which are not yet known, within the range $\lambda 2$ to 22 μ, with the aid of a prism spectrometer arranged as by Herzog and Laski [see Abstract 2388 (1926)]. The source of light is a Nernst lamp. As reflection measurements were unsatisfactory, the powdered substance confined between two rock-salt plates in a thickness of 2 or 1 mm. is placed in front of the slit for the determination of the absorption spectra. Prisms of fluorspar (for $\lambda 2$ to 8μ), rock-salt (8 to 15), and sylvin (15 to 22) are used. According to Born and Brester [see Abstract 2435 (1924)] the proper vibrations should be limited to one or two harmonic frequencies; but the measurements show in all cases inharmonic vibrations. MgO gave the fundamental frequency ν ($14 \cdot 2\,\mu$) and further 2ν and 4ν; CaO the fundamental ν at $22 \cdot 05\,\mu$ and further 2ν; neither gave 3ν. The spectra of BeO and ZnO were more complex; both gave three fundamental vibrations, ν_1, ν_2, ν_3, and also $2\nu_1$ and $2\nu_2$, further (but only in combinations) $3\nu_1$ and $4\nu_1$, and $3\nu_2$ and $4\nu_2$. The values of $\beta\nu$ deduced from these proper frequencies were in fair agreement with those derived from the melting point, compressibility and specific heat data. The determination of the infra-red spectra would generally appear suitable for the study of the fine structure of crystals. Zapon varnish (nitrocellulose, amylacetate, amylalcohol, etc.), also used as material for windows, is found to absorb radiations of more than 4 μ to a considerable, irregular extent. H. B.

1486. Röntgenographic Investigations of Manganese Arsenide, Iron Telluride, Nickel Stannide and Platinum Stannide. I. Oftedal. *Zeits. f. phys. Chem.* 132. 3–4. *pp.* 208–216, *March*, 1928.

Exact measurements by Wyckoff's procedure have established the following hexagonal cell elements (dimensions in Å.):—

	c.	*a.*	*c/a.*
Manganese arsenide...	5·704 ± 0·006	3·716 ± 0·003	1·535
Iron telluride	5·651 ± 0·005	3·800 ± 0·003	1·487
Nickel stannide	5·174 ± 0·003	4·081 ± 0·002	1·268
Platinum stannide ...	5·428 ± 0·005	4·103 ± 0·003	1·323

Assumptions made for the structure of nickel arsenide receive confirmation in the cases of manganese arsenide and platinum stannide. The same structure type is very probable for iron telluride and nickel stannide.

H. H. Ho.

1487. Asymmetric Two Centres Problem According to Wave Mechanics and its Application to Crystal Theory (Scattering Power of the Atoms). K. F. Niessen. *Phys. Zeits.* 29. *pp.* 132–143, *March* 1, 1928.

In the first part the solution of Schrödinger's wave equation for an electron in the field of two positive centres of unequal charge and separated by an arbitrary distance is derived. The work is in part a generalisation of that of Burrau [*Det. Kgl. Danske Videns. Selskab*, 7. p. 14 (1927)], who treats the case of two similar centres each carrying a charge $+e$. The eigenfunction of zero order only is required, and from this the static Schrödinger charge distribution is obtained. In Part II the solution is used to evaluate the charge distribution in the cell unit of crystal lattices of the wurzite and carbon type. For diamond, silicon, zinc blende, carborundum, BeO and Al the ratio of the scattering powers of the two types of constituent atom is calculated from the charge distribution and found to agree well with values obtained experimentally by Ott. W. S. S.

1488. Specific Gravities and Volumes of Ions and Their Compounds. J. Geissler. *Zeits. f. Elektrochem.* 34. *pp.* 86–91, *Feb.*, 1928.

Applying astrophysical considerations to atomic physics, the author points out that the sum of two masses, m_1 and m_2, in space is not $m_1 + m_2$, but $m_1 + m_2 + m_1 m_2 . g/r$, where g is the gravity constant and r the distance between the masses. Proper movements of the masses, electric charges and radiation introduce further correction terms. Similarly, the mol. volume, the sum of two ionic volumes U and V, is $U + V + UV/a^2$, where a^2 is the product of two unknown factors. The partial volume and the mol. volume may be negative, and that is so for the ionic volume of the electron e^- and for the ions of OH, F, O. A negative mol. volume is inconceivable. This may explain why the existence of these mol. volumes and their binary combinations is apparently impossible. It would further account for the fact that oxides and hydroxides are insulators (electrolytic rectifiers). The mol. volume formula of Henglein [see Abstract 1603 (1924)], $x'y' - a^2$, comes to the above when $x' = a + u$ and $y' = a + v$. From these considerations the author deduces $a^2 = -26·44$ cm.^{3} for e^- and $a^2 = 54·42$ cm.^{3} for monovalent ions. The calculated mol. volumes of the metals of the alkaline earths and of compounds between positive divalent ions and two monovalent negative ions (halogens) are mostly in good agreement with the experimental data. H. B.

1489. Relationships between the Ionisation Potentials of Homologous Elements. G. Piccardi. *Accad. Lincei, Atti,* 6. *pp.* 306–311, *Nov.* 6, 1927.

If for helium and the alkaline earth metals the difference between the ionisation potential of one of these elements and that of hydrogen or the preceding alkali metal is plotted in relation to the atomic number a regular curve is obtained. Similar curves are given by the quadrivalent elements, the quinque- and sexa-valent elements, the halogens, and the rare gases, these curves coinciding with those obtained by multiplying the ordinates for the alkaline earth metal curve by 1, 2, 3 and 5 respectively. T. H. P.

1490. Relationships between the First and Second Order Ionisation Potentials of Homologous Elements. G. Piccardi. *Accad. Lincei, Atti,* 6. *pp.* 428–431, *Nov.* 20, 1927.

Calculation by means of the system of curves already described [see preceding Abstract] gives the following values, correct to the first decimal figure, for the first order ionisation potentials: Ge 7·52; As 9·04; Sb 8·46; Bi 8·48; Se 9·02; Te 8·43; Po 8·46; Cl 12·26; Br 10·47; I 9·76; element 85 9·65; Xe 12·33; Rd 11·96. The ratio of the second order to the first order ionisation potential is found to be $r = 1\cdot 9 - 2\cdot 2$ except for the alkali metals, which give values of r varying considerably with the atomic number, and for aluminium and thallium, for which $r = 3$. From the known value, 10·23, for the second order ionisation potential of radium, this approximately constant value of r renders possible calculation of the first order ionisation potentials of radium and of the unknown element of atomic number 87, the respective values thus obtained being 5·35 and 4·24 volts. On the basis of the linear law for the alkaline earth metals, the second order ionisation potential for beryllium is calculated to be 18·8. T. H. P.

1491. Parachor and Chemical Constitution. Part VIII. Ring-Chain Valency Tautomerism in Phorone Derivatives. S. Sugden. *Chem. Soc., J. pp.* 410–415, *Feb.*, 1928.

Substitution in the $\alpha\alpha'$-positions in phorone is known to produce, to a greater or less degree, a change in structure from the open-chain configuration to the dicyclic structure. In agreement with this, it is found that, whereas phorone has a nearly normal parachor, the dibromo-derivative exhibits a high negative anomaly, which becomes still greater in the oxy- and bromo-oxy-derivatives. The parachors of substances such as dibromophorone, which are presumably equilibrium mixtures of isomerides, show no appreciable change with temperature. Hence the composition of the equilibrium mixture must remain nearly constant, and the heat evolved or absorbed by the change from the open-chain to the bicyclic structure must be small. If this is correct, the isomerides are substances which differ in reactivity (unsaturation) but have nearly the same energy content. [See also Abstract 1162 (1928).] T. H. P.

1492. Brownian Movements. K. C. Kar and M. Ghosh. *Phys. Zeits.* 29. *pp.* 143–144, *March* 1, 1928.

Starting from Kar's theory of the movements of particles under periodically repeated impulses [see Abstract 1283 (1923)], the authors arrive at a formula for Brownian movements which is identical with Einstein's formula. H. B.

1493. Chemical Valency and Spectral Multiplicity. A. T. Williams. *Univ. Nac. La Plata, Estudio Ciencias, No.* 28. *pp.* 243–253, 1928.

The dependency of spectral multiplicity on the chemical valency is expressed by the equation $V = r \pm 1$, which holds for all elements except iron, cobalt, iridium, and the rare earth metals, these being ferromagnetic or paramagnetic. The sign in the right-hand side of this expression is determined by the relationships between x, the number of electrons situated in the orbit with the greatest value of n for the normal configuration of the atom considered, and the values of N and k of Stoner's equation, $N = 2(2k - 1)$. For elements with various valencies, these should, as Niven supposes [see Abstract 2781 (1927)], have distinct electronic configurations, but the author's schemes of distribution do not coincide with those suggested by Niven. T. H. P.

1494. Applications of Spectroscopy to Molecular Problems. W. E. Curtis. *Univ. of Durham Phil. Soc., Proc.* 7. 4. *pp.* 165–167, 1926–1927.

A short account of the way in which the study of band spectra contributes to the knowledge of the structure of the molecule. H. N. A.

1495. Internuclear Reactions. B. Cabrera. *Comptes Rendus,* 186. *pp.* 501–503, *Feb.* 20, 1928.

Considers the formation of an isotope O_{17} when N_{14} is bombarded by an α-particle. The kinetic energy of the α-particle is to be added to the system, and that of the O_{17} and the proton formed is to be subtracted to find the increase in energy of the system; this is $18 \cdot 1 \times 10^{-7}$ ergs, which would correspond to an increase in mass of $2 \cdot 0 \times 10^{-27}$ gm. Aston's law suggests that the packing fraction a for O_{17} is about the same as for O_{16}. From this it would follow that in the above reaction there is a diminution of internal energy from this cause equivalent to $13 \cdot 2 \times 10^{-27}$ gm.; the total energy emitted during the reaction will be equivalent to $(2 + 13 \cdot 2)10^{-27}$ or $15 \cdot 2 \times 10^{-27}$ gm. There is no experimental evidence as to this emission, but if a quantum of radiation were emitted the wave-length would be $\gamma = 1 \cdot 44 \times 10^{-11}$ cm., and it would not be observed. Other cases are mentioned, and the paper concludes with some remarks on the evolution of elements in the stars. H. N. A.

1496. Quantum Levels and Resulting Constants of the Hydrogen Molecule. R. T. Birge. *Nat. Acad. Sci., Proc.* 14. *pp.* 12–19, *Jan.,* 1928.

The value $I_M = 15 \cdot 34$ has been calculated for the ionisation potential of the neutral hydrogen molecule from Richardson's data [see Abstract 344 (1928)]. Using Burrau's value of $16 \cdot 30 \pm 0 \cdot 03$ volts for the total energy of H_2^+, as calculated from the value $13 \cdot 54$ volts of the ionisation potential of the hydrogen atom on the basis of the new wave mechanics, and combining this with Witmer's spectroscopic value for the heat of dissociation $D = 4 \cdot 34$ volts of the neutral molecule, the author obtains $15 \cdot 12$ volts for I_M. From Condon's value of the total energy of

H_2 the value $I_M = 15 \cdot 18$ volts is obtained. Condon has shown that the apparent mean ionisation potential measured by electron impact methods will be $1 \cdot 07$ volts higher than this, owing to the fact that this amount of vibrational energy is added. Some of Richardson's results are given in terms of wave mechanics and others in terms of the old quantum mechanics. The author has reduced all Richardson's results to a standard basis using the old mechanics throughout. The energy levels obtained agree more closely than Richardson's with the observed frequencies. The adopted values of I_M and D have been checked indirectly by considering the heat of dissociation of the molecule in excited levels. The separations of the first few vibrational levels of the normal state (1^1S) lie in a very smooth curve, except for the $M = 0$ to 1 interval; such vibrational perturbations should prove of some theoretical importance. The C level of Dieke and Hopfield from its general characteristics is a ^3P level; it is not the 2^3P level as stated by Richardson, or the 3^3P level; it appears to be one of the *extra* levels predicted by Hund for hydrogen. H. N. A.

1497. Method of Determining the Number of Excited Atomic States. H. Kohn. *Phys. Zeits.* 29. *pp.* 49–52, *Jan.* 15, 1928. *Paper read before the Deut. Phys. Gesell., Breslau, June,* 1927.

When radiation from one source, the *umkehrende* (transmuting) source, passes through another vapour, the transmutable source, the brightness of the spectral lines changes with the brightness of the *umkehrende* source, as is well known from the Kirchhoff-Bunsen experiments. The results obtained can be expressed by the formula $E_\lambda d\lambda \gtreqless e_\lambda T \, . \, A_\lambda d\lambda$, where $E_\lambda d\lambda$ and A_λ are the emissive and absorptive powers of the vapour and $E_\lambda T \, . \, d\lambda$ the emissive power of the *umkehrende* source for the temperature T. The temperature at which the lines disappear is called the *umkehr* (transmutation) temperature. Special cases of the above statement are considered and the meaning of the *umkehr* temperature discussed in the light of Bohr's theory, the transformations of energy being expressed in quantum numbers as used by Einstein in the deduction of Planck's radiation law. The condition for the *umkehr* condition is deduced to be $N_k/N_i = e^{-h\nu/kT} \, . \, g_k/g_i$, where N_k denotes the number of atoms in the state denoted by the suffix k and N_i for the state denoted by i. The respective quantum weights are g_k and g_i. If the radiating body is a temperature radiator, the *umkehr* temperature T becomes its real temperature, and the expression becomes that of Boltzmann, but it has been obtained independently of whether the radiating and absorbing vapour is a temperature radiator or not. Applications of this result are discussed and reference is made to the author's results on the cæsium doublet in the nitrogen flame. [See Abstract 1005 (1927).] T. B.

1498. The New Atomic Mechanics. R. G. Loyarte. *Univ. Nac. La Plata, Estudio Ciencias, No.* 77. *pp.* 137–167, 1927. *In Spanish.*

An account of modern developments preceded by a sketch of the steps which have led up to these. A. D.

1499. Undulatory Mechanics. E. Persico. *Elettrotecnica,* 15. *pp.* 197–202, *March* 15, 1928.

A review of the Schrödinger system of mechanics. A. Wh.

1500. Central Fields and Rydberg Formulæ in Wave Mechanics. J. C. Slater. *Phys. Rev.* 31. *pp.* 333–343, *March*, 1928.

The analogy in wave mechanics is set up for the non-penetrating part of the electron orbits on the older theory, in which the motion of the outer electron is like that in the field of a point charge. The Rydberg formula follows from this as in the older theory. The separate Rydberg series for the various multiplets also are explained. The method previously applied by the writer to the helium problem appears as a next approximation, in which the outer electron moves, not in a hydrogen-like field, but in a somewhat more accurate central field. It is shown that this method should give a good approximation to the energy levels and also to the wave function, except at very small distances. The attempt to use this function as a starting point for perturbation calculations is shown, however, not to be justified, for the matrix of the Hamiltonian function H, which is used in the perturbation method, greatly magnifies the errors in the wave function. Suggestions are made as to the next step in improving the method by increasing the accuracy of the wave function for small r's. AUTHOR.

1501. Heisenberg's Indetermination Principle. E. H. Kennard. *Phys. Rev.* 31. *pp.* 344–348, *March*, 1928.

The indetermination principle of Heisenberg is discussed and applied to cases where position and velocity of an electron are observed by allowing it to pass through shutters opened momentarily at known times. The principle requires that such a shutter shall change the speed of the electron in a manner that can only be predicted statistically, in the same way as the frequency of a light quantum passing through such a shutter must usually undergo alteration to correspond with the Fourier resolution of the finite train of waves that gets through while the shutter is open. This effect is small and hard to detect experimentally. AUTHOR.

1502. Application of Statistical Gas Methods to Electronic Systems. E. Fermi. *Accad. Lincei, Atti*, 6. *pp.* 602–607, *Dec.*, 1927.

The electrons surrounding an atom can be regarded as a gas, and can be treated statistically by applying Pauli's principle of exclusion [see Abstract 1867 (1926)]. The kinetic energy of the electrons within the atom is much greater than it would be according to the principle of equipartition, and practically independent of the temperature. The author calculates the distribution of the electrons round the nucleus and the energy required for complete ionisation. E. E. F. d'A.

1503. Symmetry of Electron Grouping. P. Vinassa. *N. Cimento*, 4. *pp.* 381–398, *Dec.*, 1927.

The sum of atomic numbers of all the elements constituting a molecule is called the molecular number. It is an even number for all the substances found in the earth's crust, and out of 3831 artificial substances examined 3700 also have even molecular numbers. The author arranges all known elements in the various states of ionisation in a table of "electronyls," and points out that electronyls corresponding to electron groups 5 and 7 are absent. He concludes that electrons are arranged not according to geometrical but to crystallographic symmetry. E. E. F. d'A.

1504. Equipotential Surface Electrons as an Explanation of the Packing Effect. W. E. Deming. *Phys. Rev.* **31.** *pp.* **453–465,** *March,* **1928.**

The mutual mass of ordinary uniformly charged electrons and protons has long been known to account for only a small fraction of the packing effect, 10 % at best. By postulating that the electrons and protons shall be equipotential surface distributions having the usual total charges and radii, the writer shows that any static model for a helium nucleus can give considerably more packing than is possible with ordinary electrons. This idea is applied to two models and found to work out satisfactorily—in fact, almost any desired amount of packing could be obtained. Nuclear models in dynamic equilibrium present difficulties which have not been overcome, because the relativity increase in mass of the revolving protons seems to more than annul the negative mutual mass in the two models considered. For the same reason, ordinary electrons in these dynamic models produce negligible packing. So the situation is that with static models of the helium nucleus, packing can be satisfactorily accounted for by equipotential surface electrons but only about 10 % at most by ordinary electrons, and with dynamic models neither kind offers a solution.

AUTHOR.

1505. Problem of the Mass of a Moving Electron. T. J. I'a Bromwich. *Phil. Mag.* **5.** *pp.* **636–638,** *March,* **1928.**

The direct evidence of the Lorentz formula for the mass of an electron, moving with velocity v, namely $m = m_0/\sqrt{1 - \beta^2}$, if $\beta = \frac{v}{c}$, where c is the velocity of radiation, is derived from Bucherer's experiments and others of similar character. In these experiments the particles of radium pass through a narrow slit between the two faces of a condenser. The problem becomes more manageable by treating the condenser as composed of two large conducting blocks with plane faces at different potentials. Application of the Lorentz transformation to this arrangement shows that the lines of force cannot differ very greatly from those in the corresponding electrostatic problem. In the case $v = c (\beta = 1)$ the following two simple problems can be worked out by Heaviside's methods: (1) The supposition that the particle is moving parallel to a conducting plate at zero potential corresponds with the assumption that the electron is between the two plates, while the upper plate is far enough away to be ignored. The problem is then the same as the electrostatic problem of a circular cylinder above a plane at zero potential, the lines of electric force being arcs of coaxial circles, which are cut orthogonally by the lines of magnetic force. (2) If the particle is moving with speed $v = c$ at right angles to a plane at zero potential, the assumption is that the whole condenser can be replaced by one plane. This problem, for a point-charge, is worked out in Heaviside's *Electromagnetic Theory* (vol. i, p. 62), and all the conditions of the problem are satisfied by assuming the lines of force to be circular about a centre representing the slit in the condenser. The transverse electric force is $Q/ar \sin \theta$, using spherical polar coordinates (so that $r = 0$ gives the slit and $\theta = \pi/2$ the plane conductor). The resultant force on the electron is Q^2/avt, t being the time since the centre of the electron left the slit, and the energy is

$$\frac{Q^2}{a}\left\{\log\left(\frac{vt}{a}\right) + 1\right\}.$$

T. H. P.

1506. Quantum Theory of the Capture of Electrons. J. R. Oppenheimer. *Phys. Rev.* 31. *pp.* 349–356, *March*, 1928.

In Section 1 the method of a previous paper [see Abstract 1172 (1928)] is applied to find the rate at which α-particles capture electrons from atoms. The mean free path for capture varies roughly with the sixth power of the velocity of the α-particle and in good agreement with Rutherford's experiments [see Abstract 1205 (1924)]. The value of the mean free path is computed for capture in air, and agrees with the experimental value.

In Section 2 the probability of radiative recombination of electrons and protons is computed. The cross-section for recombination becomes infinite for small relative velocities with the inverse square of the velocity; for high velocities it is given by $10^{-18}W^{-5/2}$, where W is the energy in volts of the incident electrons. AUTHOR.

1507. Quantum Theory of the Electron. Part II. P. A. M. Dirac. *Roy. Soc., Proc.* 118. *pp.* 351–361, *March* 1, 1928.

The theory enunciated in Part I [see Abstract 1168 (1928)] is further developed, commencing with a proof of the conservation theorem, which states that the change in probability of the electron being in a given volume during a given time is equal to the probability of its having crossed the boundary. The selection rule for *j*, the quantum number determining the magnitude of the resultant angular momentum for an electron in a central field of force, is worked out and found to be exactly equivalent to the two selection rules for *j* and *k*, of the usual theory, which agree with experiment. The relative intensities of the Zeeman components of the lines in a combination doublet and the alteration of the energy levels by a magnetic field are investigated and the results shown to be in agreement with those of previous theories based on the spinning electron model. W. S. S.

1508. Electron Theory of the Surface Energy at the Boundary of Two Amorphous Media. B. M. Eidelson. *Phys. Zeits.* 29. *pp.* 200–204, *April* 1, 1928.

Follows up the statement by Frenkel that all bodies have a layer of negative electrification on their outside surfaces, due to the fact that electrons belonging to the atoms and molecules whose centres are not farther from the surface than the radius of the orbits of the external electrons will, with certain orientations of the orbits, have part of their path outside the surface; shows that there is in reality an electrical double layer at the surface, the negative layer outside the surface being balanced by a positive layer inside. Obtains an expression for the energy of the double layer; and then, taking two monatomic liquids in contact with one another, studies the mutual action of the two double layers, and deduces an expression for the energy of the surface of separation. Assumes tentatively that this expression also holds when the molecules consist of two or more atoms, calculates the surface energy for several pairs of liquids, and finds agreement with experiment with a limit of error of ± 35 %. H. N. A.

1509. How Can Atoms Radiate? H. A. Lorentz. *Frank. Inst., J.* 205. *pp.* 449–471, *April*, 1928.

This paper contains the late author's account of a lecture delivered before the Franklin Institute. It gives descriptions of the theories which have been put forward for explaining the emission of light, the theory of elastic vibrations of the atoms, the Bohr theory, that based on the dynamics of matrices, and the one put forward by L. de Broglie and developed by Schrödinger. The difficulties of the different theories are pointed out. In connection with the original quantum theory an experiment of the author's is mentioned in which the number of quanta between the screen with the diffracting aperture and a screen some distance behind it was, on an average, 0·04. Most of the time there were no quanta in this space, sometimes there was one, and very rarely there may have been two or more; this excludes the explanation that the interference phenomena which were observed on the screen were due to mutual actions between the quanta in the space between the two screens. H. N. A.

1510. Approximate Complex Solutions of Schrödinger's Differential Equation for the Harmonic Oscillator. K. F. Niessen. *Ann. d. Physik*, 85. 5. *pp.* 497–514, *March* 19, 1928.

Wentzel [see Abstract 45 (1927)] showed that Sommerfeld's rule followed as a first approximation from wave mechanics, but his proof is not rigorous, since it assumes the particular solution which satisfies Schrödinger's boundary conditions, to possess an analytical continuation which, owing to the smallness of Planck's constant, can be represented approximately in the whole plane by a single unique asymptotic solution. This is shown not to hold good for the linear harmonic oscillator. For this case, however, the present paper provides a proof of the legitimacy of Wentzel's result, which in general is inadmissible. W. S. S.

1511. Riemannian Manifolds and Non-Euclidean Space-Forms. P. Koebe. *Preuss. Akad. Wiss. Berlin, Ber.* 23. *pp.* 164–196, 1927.

The geometrical characteristics of Riemannian manifolds are discussed. J. S. G. T.

1512. Gravitation and the Special Gravitational Fields of the Theory of Relativity. G. Maneff. *Zeits. f. Phys.* 48. 1–2. *pp.* 141–148, 1928.

The intensity of the special gravitational fields of the general theory of relativity is shown to be $c^2 (= 9 \times 10^{20})$ times smaller than that of the actual gravitational field. The Newtonian law cannot be considered as an approximation to Einstein's law, and Mach's principle is incompatible with the rotational symmetry postulated in the general theory. [See also Abstract 232 (1918).] J. S. G. T.

1513. Theory of the Electrical and Gravitational Field. L. Infeld. *Phys. Zeits.* 29. *pp.* 145–147, *March* 1, 1928.

A theory of the electrical and gravitational field based upon the introduction of asymmetric components of parallel displacement, as conceived by Einstein, is developed. The length of the measuring rod is not altered by transport. The electromagnetic field is defined by the tensorial equations $(\phi_{ik}) = g_{sl}(\Gamma^s_{ik} - \Gamma^s_{ki}) = \mathrm{J}_{ikl}$. The current vector is given by $\mathrm{J}^k_{ik} = \mathrm{J}_i$. In a matter-free field, $\mathrm{R}_{ik} = 0$. Einstein's equations of the gravitational field and the Maxwellian equations follow as first approximations from the assumptions made. J. S. G. T.

1514. The Fifth Dimension in Relativistic Quantum Theory. N. Weiner and D. J. Struik. *Nat. Acad. Sci., Proc.* **14.** *pp.* **262–268,** *March,* **1928.**

The Klein form of the Schrödinger equation is shown to afford a reasonable interpretation of the function $\psi\bar{\psi}$, which Schrödinger interprets as electric density and Born interprets as the probability that an electron lies in a region of space of unit volume. A statistical theory of electronic motions leading to a function which is interpreted as a particle density in space-phase is tentatively developed. [See also Abstract No. 2831 (1927).] J. S. G. T.

1515. Extension of Thermodynamics to General Relativity. R. C. Tolman. *Nat. Acad. Sci., Proc.* **14.** *pp.* **268–272,** *March,* **1928.**

Two principles, expressed in the form of tensorial equations true for all sets of coordinates, and which are analogous, in general relativity, to the first and second laws of thermodynamics, are discussed. [See also Abstract 311 (1927).] J. S. G. T.

1516. Quantum and Relativity Theories of Light. E. T. Whittaker. *Engineering,* **125.** *p.* **372,** *March* **30, 1928.** *Paper read before the Royal Inst., March* **16, 1928.**

Contemporary difficulties of atomic physics, photoelectricity and the gravitational and electromagnetic fields are briefly referred to. J. S. G. T.

1517. Relativity and Wave Mechanics. W. Wilson. *Roy. Soc., Proc.* **118.** *pp.* **441–448,** *April* **2, 1928.**

The equations of a geodesic in a five-dimensional continuum and a generalised form of Schrödinger's equation for a charged particle are deduced. It is shown that the probability that a particle at any time is within a specified volume depends, in some way, upon Schrödinger's wave function, and that in the case of sufficiently small neutral particles the wave equation is the familiar one for the propagation of light in empty space. J. S. G. T.

1518. The Michelson Experiment Carried Out in a Balloon and at Earth Level. A. Piccard and E. Stahel. *J. de Physique et le Radium,* **9.** *pp.* **49–60,** *Feb.,* **1928.**

A form of Michelson interferometer of small dimension but of the same order of sensitivity as, and of greater precision than, the larger type used in America is described. With this apparatus no evidence of an ether drift, outside the limit of error of experiment, was detected at the Righi at an altitude of 1800 metres, at 2500 metres high in a balloon, or in Brussels at normal earth level. [See also Abstract 1662 (1927).] J. S. G. T.

METEOROLOGY AND GEOPHYSICS.

1519. The Meteorological Views of Wilhelm Blasius. H. v. Ficker. *Preuss. Akad. Wiss. Berlin, Ber.* **33.** *pp.* **248–267, 1927.**

The author reviews the life-work of Blasius in relation to meteorological discoveries, and the paper forms a vindication of his prior claim to the views on modern polar front meteorology, the close relation of his scheme to polar front theory, and explanations given by him of it. He recognised in his earliest investigations on the West Cambridge tornado of 1851 the necessity for two air currents of different temperatures and densities in the development of a depression, and wrote regarding the characteristic cloud formations at the boundary of the two currents. The surfaces of discontinuity being recognised, he identified the modern warm and cold fronts with separate "low- and high-pressure storms." Their respective cloud forms and precipitation zones were also found and a schematic representation bears many points of resemblance to a modern picture of a depression. Although not aware of later developments by Helmholtz and Margules, his general ideas on the movement of depressions along the polar front and its position and slope in different latitudes closely resembles later ideas. The author considers that the writing of most of his publications in a foreign language and in a place not readily accessible to others, combined with his disinclination to accept the use of synoptic meteorology, hindered the acceptance of his views and led to his work being largely ignored. R. S. R.

1520. Circulation of the Atmosphere above Melbourne. E. Kidson. *Roy. Meteorolog. Soc., J.* 54. *pp.* 27–40; *Disc.*, 40–41, *Jan.*, 1928.

Discussion of a long series of nephoscope observations of high cloud made at Melbourne. The subject is treated under the following heads: Annual Variation in Cirrus Velocity. Velocity of Alto-Cumulus. Correlated Annual Variations. Variations during the Solar Cycle. The Three-Year Cycle. It is shown that it is possible to obtain estimates of wind velocity at high levels by nephoscopic observations with sufficient accuracy for most purposes. No other means are at present available for securing a comparable amount of data for the same levels in a climate such as that of Melbourne. These upper winds are freed from the purely local effects which make the treatment of surface winds so difficult. Much information can, therefore, be deduced from them regarding the general circulation. On the other hand, it is clear that large-scale local effects are still of great importance, so that the conclusions which can be drawn from the observations at one station are very limited. The relationships of cirrus velocity with a number of fluctuations of the general circulation are shown. These are not simple, and the author has so far been unable to obtain a clear mental picture of the processes involved. It was felt, however, that the results so far evolved were of sufficient interest to be placed on record. In the *Discussion*, **N. Shaw, G. C. Simpson, D. Brunt** and **F. J. W. Whipple** bore testimony to the great value of the author's observations. E. F.

1521. Influence of Forests on Rainfall and Run-Off. C. E. P. Brooks. *Roy. Meteorolog. Soc., J.* 54. *pp.* 1–13; *Disc.*, 13–17, *Jan.*, 1928.

Examination of a large amount of data regarding the loss of water from forests due to (*a*) rainfall intercepted by crowns of trees and reevaporated before reaching the ground, (*b*) water evaporated from the soil of the forest, and (*c*) water transpired by trees leads to figures of 47 % for forests, 54 % for crops and 30% for bare soil. Consideration was next given to the effects of forests on orographical and cyclonic rains, instability showers, fog-rain or drizzle, deposition of moisture from fog, and dew and hoar-frost. It was concluded that (1) replacement of forests by field crops or grass lands increases the general rainfall slightly, but bare ground decreases it slightly; (2) forests increase the local rainfall by

1–2 % because of the increase in effective level of the ground by trees and increased friction; (3) in favourable mountain situations forests enveloped in clouds acquire an increased water supply; (4) afforestation of grass or crops land increases the local run-off by 10–20 %, due to decreased evaporation and transpiration losses and to a slight increase of rainfall; afforestation of bare ground would decrease the run-off, but this effect would be masked by the much greater regularity of the flow; and (5) forests drawing their water supply from deep sources possibly exercise a slight mitigating effect on droughts. In the *Discussion*, **H. R. Mill** stated that the New Forest affected the rainfall of Hampshire in the way mentioned in the paper. **L. C. W. Bonacina** said that in some areas, notably Australia, afforestation increased and in others decreased the rainfall. R. S. R.

1522. Correlations of World Weather and a Formula for Forecasting the Height of the Parana River. E. W. Bliss. *Roy. Meteorolog. Soc., Mem.* 2. 14. *pp.* 39–45, *Feb.*, 1928.

The author has correlated the temperature at St. Vincent, rainfall in Southern Rhodesia and the height of the Parana River as measured at Rosario, in the Argentine, with each of the thirty-five centres of world weather selected by G. Walker. It was found that the temperature at St. Vincent was lowered when the circulation of the N. Atlantic increased and there was also a positive correlation with sunspots. The rainfall in Southern Rhodesia, based on observations for several hundred stations, was found to be increased by high pressure and low temperature at Mauritius and itself influenced the subsequent rainfall of India. The Parana River was found to be low following pressure higher than normal at Samoa and after pressure below normal at Port Darwin. No significant relation with future weather was found, but a formula was obtained on which was based a forecast in September of the probable height of the river in November to May. R. S. R.

1523. Report of the International Days of 1923. N. Shaw, R. G. K. Lempfert and Elaine Austin. *Roy. Meteorolog. Soc., J.* 54. *pp.* 43–58; *Disc.*, 58–62, *Jan.*, 1928.

The report is intended as a specimen of a proposed international publication of the results obtained by the cooperation of the various countries. The first part contains among other matters the regulations laid down, comments upon them, and a list of reporting stations. The second part presents the list of data available for the thirty-six international days of 1923 and maps of the pressure distribution over the northern and southern hemispheres for each of the days. The data comprise records of pressure, temperature and humidity in the upper air obtained from registering balloons, captive balloons, kites and mountain stations, records of wind direction and velocity obtained at mountain stations or from kites, registering balloons, pilot balloons or clouds, together with any supplementary information about the weather at the stations or elsewhere to assist in comprehending the meteorological situation. The third part contains numerical tables of the data classified according to types. The fourth part gives a graphic representation of each of the soundings with registering balloons upon a form specially designed. This $t - \phi$ diagram, corresponding closely with the steam-engine indicator diagram, assists in comprehending the state of the atmosphere in relation to energy. In the *Discussion*, **G. C. Simpson** and **G. Walker** both objected to the use of dynamic metres for heights, for the percentage errors in the observations do not justify the change from metres. **E. Gold** considered that tables of results were of more importance than diagrams, especially for the investigation of discontinuities. R. S. R.

1524. Errors in the Multiple Correlation Coefficient due to Random Sampling. J. Wishart. *Roy. Meteorolog. Soc., Mem.* **2.** 13. *pp.* 29–37, *Feb.*, 1928.

The author refers to G. Walker's use of the multiple correlation coefficient in weather forecasting, *e.g.*, in regarding the monsoon rainfall of India as a dependent variate affected by a number of independently varying factors. The general expression for the multiple correlation coefficient is examined. It is concluded that when there is no real multiple correlation between the factors studied, definite values for the mean of a large number of samples, and for the variance, occur. These are given by the formulæ cited and the formula $(1 - R^2)^2/N$, whatever its applicability may be where correlation is present, fails entirely when $R = O$. Applying either $R = O$ or the value derived from a particular sample to the formula leads to a value much too large for the standard deviation. It is further shown that R. A. Fisher's theory applied to the limited sample of experiments, gives a reasonably good fit, as measured by Pearson's criterion. The probability that any specified value of R will be exceeded by chance is given by a particular mathematical function, tables for which are being prepared. The form of the results for the more general case of real relationship existing between the factors is suggested, but the theory is incomplete. R. S. R.

1525. Studies in Terrestrial Radiation. G. C. Simpson. *Roy. Meteorolog. Soc., Mem.* **2.** 16. *pp.* 69–95, *March*, 1928.

An exhaustive treatise on the subject of the title up to date. Water vapour is assumed to be the only constituent of the atmosphere which absorbs and emits long-wave radiation. Approximate values of the temperature and water content of the atmosphere at all heights and in all latitudes are adopted from upper air observations. Knowing the absorption coefficient of water vapour and the amount of water vapour and the temperature, the outgoing radiation can be calculated. One mm. of precipitable water in vapour form absorbs 30 % of the incident long-wave radiation. With this value for the absorption coefficient the total outgoing radiation is calculated for each latitude from the equator to the pole. Over three-quarters of the earth's surface—from the equator to latitude 50°—the outgoing radiation is uniform and independent of the temperature of the surface, the layers of the atmosphere whose temperature lies between 220° and 286° only contributing to the outgoing radiation. These layers are well within the troposphere between the equator and latitude 50, hence the outgoing radiation is uniform between 50° N. and 50° S. At higher latitudes the radiation falls off, and at the pole itself it is 20 % below its equatorial value. The problem as to the way in which the temperature of the atmosphere readjusts itself to changes in solar radiation is discussed but no solution is given. S. G. B.

1526. Plasticity in Mountain Formation. M. Bossolasco. *Accad. Lincei, Atti,* **7.** *pp.* 66–71, *Jan.* 8, 1928.

General discussion of the effects of plasticity in the magna underlying the earth's crust. This plasticity may be brought about by pressure and depends upon the material, the size of grain, the presence of impurities, the temperature and the time. As promoting plasticity we have stress-differences, temperature and time. The super-pressures which promote plasticity may also provoke deformations which lead to fractures of displacement; contractions may lead to open cracks. A. D.

1527. Measurement of Oscillations of the Ground and Buildings Produced by Machines and Traffic. G. Angenheister and W. Schneider. *Zeits. f. tech. Phys.* 9. 3. *pp.* 115–118, 1928.

Measurements were made with photographically recording seismographs of the oscillations set up by a running motor and by traffic in the different floors of a building and at different distances from the disturbance. The maximum disturbance occurs with a period in agreement with or near to the natural period of vibration of the building. Forced vibrations of other periods rapidly die out. The decrease of the amplitude as a function of the distance from the place of disturbance is established. At a distance of 50 to 60 m. the amplitude is only 1/10. Comparing different floors, the vibration on the first floor is five times and on the second floor twenty times greater than that at the surface.

R. S. R.

ASTROPHYSICS.

1528. Pressures in the Calcium Chromosphere and the Reversing Layer. E. A. Milne. *Roy. Astron. Soc., M.N.* 88. *pp.* 188–202, *Jan.*, 1928.

In a recent paper Unsöld gives $1\cdot 7 \times 10^{-7}$ atmos. as the pressure in the calcium chromosphere [see Abstract 286 (1928)]; the gas pressure and radiation pressure combined cannot, however, support a column 10,000 km. high. His theory of the formation of Fraunhofer lines stands, since the number of atoms on which it is based really exists in the reversing layer below the chromosphere, though at a higher pressure and in a thinner layer than he assumed. The author works out the theory of the reversing layer and chromosphere; the latter consists almost entirely of Ca^+ atoms and free electrons, with a pressure of the order of 10^{-13} atmos.; the reversing layer is in local thermodynamic equilibrium, and the ratio between Ca^+ and Ca^{++} atoms at the boundary with the chromosphere is about $0\cdot 02$; lower down the fractional concentration of Ca^+ increases to almost unity, and still lower diminishes again, that of Ca atoms increasing. The pressure of Ca^+ atoms in the chromosphere is continuous with that at the upper boundary of the reversing layer, from which Ca^+ atoms are ejected to form the chromosphere. Selective radiation pressure balances gravity in the chromosphere. Ionisation of a Ca^+ atom occurs from time to time in the chromosphere, the Ca^{++} atom formed falls back into the reversing layer, and is replaced by the ejection of another Ca^+ atom. H. N. A.

1529. Total Absorption in Sun's Reversing Layer. E. A. Milne. *Observatory*, 51. *pp.* 88–96, *March*, 1928.

Minnaert has expressed the total energy disappearing from the continuous spectrum by the formation of an absorption line as a multiple of the sun's emission of energy per Ångström unit in the neighbouring continuous spectrum and has found for these "true intensities," (i), of the weaker lines, the empirical formula connecting them with Rowland intensities, (R): $i = 0{\cdot}046 + 0{\cdot}022\mathrm{R} + 0{\cdot}0041\mathrm{R}^2$. Approximately 15 % of the total energy of the sun's spectrum is missing in absorption lines. The author assumes that the energy dammed back in the Fraunhofer lines is returned to the layers beneath, thus raising their temperature; therefore the rate of decrease of intensity from the centre to the limb is reduced. Assuming a definite interface between the photospheric and reversing layers, he finds $u = 3/5$ as the coefficient of darkening (u) of the disc in the absence of a reversing layer; and that if the reversing layer returns to the photosphere the fraction η of the radiation it received from it, then $u = 3(1 - \eta)/(5 - \eta)$, showing that the darkening is less pronounced. From integrating Abbot's intensities, the author had found $u = 0{\cdot}54$, giving $\eta = 0{\cdot}12$; Minnaert's observed η is $0{\cdot}15$, which would give $u = 0{\cdot}525$, in good agreement with the above. For the temperature at the base of the reversing layer he finds 5200°, and that not only is the darkening as a whole reduced, but the darkening for a given λ is further reduced; and that the assumption is a fact that the general coefficient of absorption (k) is a constant independent of λ, and so must be put on the list of solar features awaiting explanation, since Eddington suggests that, theoretically, it is the emission coefficient that should be independent of λ. There is a reconciliation between the lower (effective) temperatures found directly from the solar constant *via* Stefan's law, and the higher (colour) are found from the shape of solar-energy curves *via* Planck's law. A. S. D. M.

1530. Constitution of the Solar Atmosphere. S. B. Nicholson and N. G. Perrakis. *Comptes Rendus*, 186. *pp.* 492–495, *Feb.* 20, 1928.

A discussion of the probable cause of the spectroscopic absence of certain elements from the sun. A diagram showing the relation between ionisation potential and atomic number on which the absent elements are marked shows that in general the elements with the high ionisation potentials are absent. Exceptions to this rule occur, especially at the ends of the scale where complicating conditions may apply. A. Wh.

1531. Integral Equation of Radiative Equilibrium. V. Ambarzumian and N. Kosirev. *Zeits. f. Phys.* 47. 7–8. *pp.* 602–607, 1928.

As the papers published by Wegner [see Abstracts 859 and 860 (1928)] appear to point to a partial misunderstanding arising from the brevity of the authors' previous paper [see Abstract 1686 (1927)], they now proceed to give some further explanations. With this object the integral equation of radiative equilibrium is discussed, and the limits within which a theorem of the authors' holds good are sharply defined. E. F.

1532. Equilibrium of a Rotating Fluid Mass. R. Wavre. *Comptes Rendus*, 186. *pp.* 491–492, *Feb.* 20, 1928.

In an earlier paper [Abstract 865 (1928)] three classes of rotations have been enumerated. An expression $dg/dx - cg = -4\pi\epsilon\rho + 2\omega^2 + 2l^2 \,.\, d\omega^2/dl^2$ is derived, which has also been shown to apply to the third class of rotations if the partial derivative of ω^2 be taken, surfaces of equal pressure taking the place of surfaces of equal density in the second class. A. Wh.

1533. Problem of the Colour Index in Astronomy. G. Tiercy. *Accad. Lincei, Atti*, 6. *pp.* 301–305, *Nov.* 6, 1927.

Investigation of the spectrum of SU Cassiopeiæ has been extended to a study of the variations of the temperature T, of the ray R, of the mean pressure P prevailing in the reversing layer of the star, of the colour index I, and of the ionisation in the reversing layer. The results obtained show that the least advanced spectrum A_{8-9} does not correspond with the maximum of light or with the phase of maximum temperature; moreover, the minimum temperature and the most advanced spectrum F_8 do not coincide with the minimum of light. For equal magnitude the colour index is less on the ascending than on the descending branch of the light curve. In other words, the temperature is greater on the ascending than on the descending branch in accordance with the relation $I = 7200/T - 0{\cdot}611$. For equality of spectral type the index I is lower on the ascending than on the descending branch. T. H. P.

1534. Spectroscopic Parallaxes of β-Type Stars (Fifth Paper). The Parallaxes of 125 Stars. D. L. Edwards. *Roy. Astron. Soc., M.N.* 88. *pp.* 175–181, *Jan.*, 1928.

The parallaxes are determined by two methods: (1) Photometric measures of the intensities of certain helium and hydrogen lines by means of a graduated optical wedge; (2) classification, both of spectral type and line character. Personal equation in wedge measurements is found to be slowly variable. Four tables are given of stars measured by one method or the other or by both. [See also Abstract 2238 (1927).] A. S. D. M.

1535. Faint Stars in Selected Areas with Large Proper Motions. Third List from Radcliffe Observatory, Oxford. H. Knox-Shaw. *Roy. Astron. Soc., M.N.* 88. *pp.* 181–182, *Jan.*, 1928.

A list of nineteen stars with proper motions as large as 0″·1 per annum from fifteen areas. Particulars are given of two stars in area 62 which have a common proper motion. [See also Abstract 1776 (1926).] A. S. D. M.

1536. Absorption Borders in Spectrum of υ Sagittarii. R. H. Curtiss. *Roy. Astron. Soc., M.N.* 88. *pp.* 203–205, *Jan.*, 1928.

A quantitative comparison of the three dark satellites on the side of short wave-length hydrogen absorption lines in *υ* Sagittarii [see Abstract 935 (1927)], with the Be stars, *β* Lyræ and *γ* Cassiopeiæ. In *β* Lyræ four such components are found on each edge of the emission lines, each component expressed as velocities being displaced to the same extent and the intensities of the satellites have been subject to change. In *γ* Cassiopeiæ eight absorption components—four on each border—are also found and almost in the same positions as in *β* Lyræ with respect to the centres of emission lines. The author suggests that other Be stars be examined. He gives as a working picture of some of the complex lines in these that a wide absorption band, composed of many narrow lines, has superposed on it a narrower emission line which itself may be reversed; the emission may, in a given star, lie nearly in the centre of the wide absorption, two equally strong absorption borders showing similar systems of satellites; or the emission may be decentred (permanently or periodically) in the absorption. A. S. D. M.

LIGHT.

1537. Colour and Magnetic Properties of Ions. G. Joos. *Ann. d. Physik*, 85. 5. *pp.* 641–642, *March* 19, 1928.

The conclusions drawn in the earlier paper [see Abstract 956 (1927)] are found to be further substantiated by the recent measurements of the spectra of Ti^{++} and Ti^{+++} by Russel and Lang. W. S. S.

1538. Change of Reaction Time with Illumination. H. Pottevin and R. Faillie. *Comptes Rendus*, 186. *pp.* 716–717, *March* 12, 1928.

Describes measurements of the speed with which the commencement of movement of an object can be detected by the eye when the object and its background have various illuminations between 0·7 and 140 lux. The reaction time drops rapidly from about 0·33 sec. at the lowest illumination to 0·20 sec. at about 30 lux. Thenceforward it falls only very gradually indeed to 0·19 sec. at 140 lux. J. W. T. W.

1539. New 18-Inch Cœlostat. *Nature*, 121. *pp.* 247–249, *Feb.* 18, 1928.

Spectrographs used for solar investigation are of considerable weight and length and cannot be fixed to the equatorial telescope, but they are fixed in a room and the solar image reflected to them by a mirror. The cœlostat avoids the defect of rotation of the image. It consists of a plane mirror rotatable about an axis parallel to its upper plane silvered surface and to the earth's axis and rotating in forty-eight hours in a direction opposite to that of the earth, the image thus appearing at rest. To get light in a convenient direction, usually vertical or horizontal, it is necessary to place a second mirror in its path. The instrument for the Canberra Observatory has a mirror of pyrex glass which, with its lower expansion coefficient, produces less image distortion. The driving clock is perpetually wound by a small electric motor. Quick and slow motions of the mirror are obtained by electrical operation, controlled from a distance by suitable magnets and a reversible motor. When mounted, a second mirror on a rotatable carriage at the top of the building directs the beam of light vertically downwards through the 12-in. objective, and thence it is reflected by a second mirror into the horizontal spectrograph. Full details are given of the various parts of the whole apparatus. R. S. R.

1540. Images with Inclined Mirrors. H. Maurer. *Phys. Zeits.* 29. *pp.* 147–149, *March* 1, 1928.

The author criticises some of the results obtained by T. Oryng [see Abstract 1229 (1928)], regarding the number of images obtained and the visibility of them. He takes the case of two mirrors inclined at an angle α and an object situated at an angular distance γ from one mirror and sets out in tabular form the number of images visible from different parts of the space between the mirrors. In the table α is taken with values of 32, 40, 50, 55, 60, 65, 72, 75, 85 and 100°. R. S. R.

1541. Some Uncultivated Optical Fields. T. Smith. *Optical Soc., Trans.* 28. 5. *pp.* 225–284, 1926–1927.

In considering the present position of geometrical optics attention is drawn to differences which often exist between instructional methods and those followed practically. The author develops the subject graphically for collinear and for real optics, dealing first with refraction at a simple spherical surface and extending this to the case of simple lenses of various forms. Geometrical optics is next considered algebraically, rays and waves being employed. The characteristic function and the eikonal are obtained and various applications made. The eikonal is constructed for various surfaces. The aberration coefficients for a single lens are next found and also the means employed for balancing the aberrations in an optical system. Finally, the theory of narrow lenses is investigated.

R. S. R.

1542. Design of Reflecting Prisms. T. Y. Baker. *Optical Soc., Trans.* 29. 2. *pp.* 49–69; *Disc.*, 69–70, 1927–1928.

The displacement of a bundle of light resulting from two plane reflections is the equivalent of a " swing " of the emergent part of the bundle round the line of intersection of the two reflecting faces. Prisms can be designed by considering pairs of reflections. Graphical work for the directions of the axial ray and the disposition of the field round that ray can be worked out by means of a spherical diagram from which sufficient information can be derived to facilitate the construction of models (*a*) of the path of the axial ray and (*b*) of the full bundle of light. From the second model (*b*), constructed reasonably to scale, a wooden model of the prisms can be built up. The angles between faces of the prism can be computed accurately from the spherical diagram. The method is particularly applicable to " skew " prisms in which three successive parts of the axial ray do not lie in a plane. Binocular prism systems are dealt with in some detail.

AUTHOR.

1543. Toric Lenses. T. Smith. *Optical Soc., Trans.* 29. 2. *pp.* 71–85; *Disc.*, 85–87, 1927–1928.

A system of toric lenses having a common normal to all their surfaces possesses in general ten independent primordial coefficients. A single surface has only three degrees of freedom, and this number also holds for any system of negligible axial depth. Formulæ are given for the calculation of the ten coefficients, which are only all independent when the system includes at least three separated toric refracting surfaces with their planes of principal curvature finitely inclined to one another. An eye with both its cornea and its crystalline lens astigmatic and the meridians of principal curvature different has more independent coefficients than a spectacle lens has effective degrees of freedom. The nature and importance of the unavoidable residual errors in central vision when such an eye is corrected by a toric lens are discussed.

AUTHOR.

1544. Canonical Forms in the Theory of Asymmetrical Optical Systems. T. Smith. *Optical Soc., Trans.* 29. 2. *pp.* 88–98, 1927–1928.

Canonical forms for the quadratic terms of the eikonal and of the characteristic function for any optical instrument are found to involve only six arbitrary constants. In the eikonal defined by

$$\begin{aligned}\mathcal{E} = {} & \text{constant} + \text{first order terms}\\ & + \tfrac{1}{2}a\mathrm{M}^2 + \tfrac{1}{2}b\mathrm{N}^2 + \tfrac{1}{2}c\mathrm{M}'^2 + \tfrac{1}{2}d\mathrm{N}'^2 + e\mathrm{MN} + f\mathrm{M}'\mathrm{N}' - g\mathrm{MN}' - h\mathrm{M}'\mathrm{N}\\ & \qquad - i\mathrm{MM}' - j\mathrm{NN}'\\ & + \text{higher order terms,}\end{aligned}$$

in addition to removing the first order terms we may take any of the following simplifying conditions:—

$$a = b = c = d = 0,$$
$$a + b = c + d = e = f = 0,$$
$$a + b = c + d = g = h = 0.$$

Similarly in the characteristic function

$$\begin{aligned}\mathrm{V} = {} & \text{constant} + \text{first order terms} \\ & + \tfrac{1}{2}\mathrm{A}y^2 + \tfrac{1}{2}\mathrm{B}z^2 + \tfrac{1}{2}\mathrm{C}y'^2 + \tfrac{1}{2}\mathrm{D}z'^2 + \mathrm{E}yz + \mathrm{F}y'z' - Gyz' - Hy'z \\ & \quad - \mathrm{I}yy' - Jzz' \\ & + \text{higher order terms,}\end{aligned}$$

the first order terms may be removed and in addition we may put

$$\mathrm{A} = \mathrm{B} = \mathrm{C} = \mathrm{D} = 0,$$

or $$\mathrm{A} + \mathrm{B} = \mathrm{C} + \mathrm{D} = \mathrm{E} = \mathrm{F} = 0,$$

or $$\mathrm{A} + \mathrm{B} = \mathrm{C} + \mathrm{D} = \mathrm{G} = \mathrm{H} = 0.$$

The seven constant canonical form of the characteristic function obtained by Larmor, *viz.*:—

$$\begin{aligned}\mathrm{V} = {} & \text{constant} + \tfrac{1}{2}\mathrm{A}y^2 + \tfrac{1}{2}\mathrm{B}z^2 + \tfrac{1}{2}\mathrm{C}y'^2 + \tfrac{1}{2}\mathrm{D}z'^2 + \mathrm{E}yz + \mathrm{F}y'z' \\ & - I(yy' = zz') + \ldots,\end{aligned}$$

is not general. Larmor's theorem on the equivalence of any optical system to a symmetrical instrument together with two thin astigmatic lenses also fails. Three separated astigmatic lenses are needed to represent the general system. AUTHOR.

1545. Description of the Exhibits at the Eighteenth Annual Exhibition of the Physical and Optical Societies. Optical Instruments. W. B. Coutts. *Journ. Sci. Instruments*, 5. *pp.* 66–72, *Feb.*, 1928.

Reference is made to the very complete ranges of photographic lenses, telescopes and microscopes exhibited. Details are given of a new N.S. autokine camera, extra wide field and light-weight prismatic binoculars, several types of projection lanterns, epidiascopes, kinematograph projectors and profile projection apparatus, a new refractometer in which special attention has been paid to stability and convenience in use, a new pattern of Hilger all-metal quartz spectrograph, a new model wave-length spectrometer, an infra-red spectrometer, the McLennan fluorite-vacuum spectrograph and the K. B. B. Gallois shadowless lamp. R. S. R.

1546. Mechanical Design of Instruments. A. F. C. Pollard. *Journ. Sci. Instruments*, 5. *pp.* 88–92, *March*, 1928.

The author describes noteworthy features of the following instruments shown at the Exhibition of the Physical and Optical Societies, 1928: The Ross kinematograph projector, dealt with fairly fully; a screw-measuring machine, made by Ottway & Co., Ltd.; the design of the Laby X-ray spectrograph, and the goniometer fitting of the Müller X-ray goniometer-spectrograph, both exhibited by Adam Hilger, Ltd. Suggestions are also given for improvements which would result in a better general performance, without additional cost. R. C. F.

1547. New Prismatic Spectrometer or Monochromator. C. Leiss. *Zeits. f. Phys.* 47. 1–2. *pp.* 137–142, 1928.

A long wave-length spectrometer or monochromator of the constant deviation pattern, which employs either one or two prisms at will, of glass, quartz, or rock-salt, together with concave mirrors, or lenses as desired, for collimating the light. Minimum deviation is secured. A. C. M.

1548. New Direct-Vision Spectrometer and Monochromator. C. Leiss. *Zeits. f. Phys.* 47. 1–2. *pp.* 143–146, 1928.

Light passes successively through a collimator, a prism, a Wadsworth mirror, a second such mirror, a second prism, and then the telescope. The planes of the two mirrors are continuations of the planes of their respective prisms. The instrument is a symmetrical one, deviations in the collimator, first prism and first mirror being exactly counterbalanced by reverse deviations in the second set. The prisms and mirrors are moved simultaneously by a wave-length drum.

If required to use only one prism, then the second mirror and prism can be removed together, and the telescope is lowered so as to receive the light from the first mirror directly. A. C. M.

1549. Comparison of Optical Systems [for Lighthouses]. J. Rey. *Comptes Rendus*, 186. *pp.* 855–857, *March* 26, 1928.

Comparative measures showed a superiority in the ratio of 2·66 to 1 for a system with metallic mirrors over a system with lenses. T. M. L.

1550. Accurate Investigations with a Double-Image Distance-Measurer. K. Lüdemann. *Zeits. f. Instrumentenk.* 48. *pp.* 109–113, *March*, 1928.

The author examines in detail the results obtained with other types of apparatus for the measurement of distance and the accuracy to be expected with them. With the double-image instrument a series of measurements was made over distances measured also directly, and the errors, personal and instrumental, were found. The results are set out in a series of tables. R. S. R.

1551. New Theodolite. G. Perrier. *Rev. d'Optique*, 7. *pp.* 28–36, *Jan.*, 1928.

Details are given of a repeating instrument, the two circles being read by microscopes to ten seconds. The telescope has an objective of 30 cm. focal length and 5 cm. aperture. A feature of the instrument is the electric illumination of all the scales. F. S.

1552. New Wild Precision Theodolite. P. Werkmeister. *Zeits. f. Instrumentenk.* 48. *pp.* 114–116, *March*, 1928.

Particulars are given of the structural details of the instrument and the results of a series of measurements made to determine the accuracy of the readings. The theodolite is convenient and simple to use. The eyepiece of the telescope and of the reading microscope are arranged to be side by side while in the field of view of the latter the readings at the opposite ends of a diameter of the circles are simultaneously visible. Magnifications of 24, 30 and 40 diameters can be obtained with the telescope. The graduated circles are protected from damp and dust. As the outcome of direct tests mainly under unfavourable conditions of illumination the mean error was found for magnifications of 24, 30 and 40 times to be respectively ± 1″·13, ± 0″·84, and ± 0″·80. R. S. R.

1553. Distortion. A New Interpretation of an Old Experiment. V. Ronchi. *Accad. Lincei, Atti*, 6. *pp.* 149–152, *Sept.*, 1927.

The distortion of optical images is usually demonstrated by an experiment which has become classical. A square-meshed grating, drawn on ground glass and brightly illuminated, constitutes the object of which an image is to be formed by an optical system with strong spherical aberration. The image in the conjugate plane is so blurred as to be indistinguishable, unless perhaps in the paraxial region, but becomes very distinct if a diaphragm be inserted before or behind the lens. There is, however, distortion varying in type according to the position of the diaphragm. In each case the distortion increases with the distance between lens and diaphragm, and disappears when this is zero. The explanation of these phenomena is simple and familiar. This experiment is usually associated with another which appears to present points of analogy. On viewing a reticular structure through a lens with marked spherical aberration, strong distortion is observed which varies according to the position of the eye and the object respectively to the lens. When the object is so close to the lens that the image is virtual we have one type of distortion; on placing the object beyond the focus and the eye farther from the lens than the real image we have another type. As the eye approaches the lens the distortion increases and becomes very complex. The maximum distortion and the inversion of type occur when the eye is as far from the lens as the real image of the grating. The two experiments differ essentially. The second refers to another and more complex order of phenomena of which the author is unable to trace any satisfactory explanation. He therefore refers to the description of an experiment made by him three years ago [see Abstract 80 (1925)]. [See also Abstract 66 (1928).] E. F.

1554. Precise Determination of the Privileged Directions in a Weakly Doubly-Refracting Plate. G. Szivessy and C. Münster. *Zeits. f. Phys.* 47. 5–6. *pp.* 357–361, 1928.

An arrangement is described employing crossed Nicols, in between which are placed the crystal plate under examination, a quarter-wave plate (a Soleil compensator set to ¼λ for the wave-length used was actually employed), and a Nakamura plate. The orientation of the rotating system carrying the test plate could be determined to half a minute of angle. A. C. M.

1555. Refraction of Astigmatic Pencil: Sturm's Third Equation. M. Dufour. *Comptes Rendus*, 186. *pp.* 631–632, *March* 5, 1928.

Gives a simple derivation of Sturm's third equation, demonstrating that the refracted ray remains in the plane of incidence on passing from one ray of an astigmatic pencil to the ray indefinitely near. J. W. T. W.

1556. Photoelasticity. K. Banerjee. *Indian Journ. Phys.* 2. *pp.* 195–242, *Jan.* 31, 1928.

A theory of stress-optic effect in isotropic solids. For crystalline media the birefringence brought about by the effect of the polarisation doublets of the displaced atoms or ions of the strained medium is calculated by a method similar to that of Bragg for calculating the natural birefringence of crystals; the results, though agreeing in some cases, are quite wide of the experimental results in others. This is due to the anisotropic change of mol. refraction of the ions due to their anisotropically changed positions. The birefringence due to this cause is calculated; the results are in fair agreement with the experimental results. For amorphous solids the effect of polarisation doublets vanishes, and only deformation of the ions is responsible for the birefringence; several experimental phenomena are explained on this theory. A. D.

1557. Polarisation of Tyndall Light by Colloids. B. Lange. *Zeits. f. phys. Chem.* 132. 1–2. *pp.* 1–26, *Feb.*, 1928.

The polarisation of Tyndall light by colloids was investigated by means of a spectrophotometer of the Koenig-Martens type, and the method was adapted to the investigation of colloids generally. Following a principle laid down by Gans, the depolarisation was taken as an indication of polarisation. The depolarisation was found to depend upon the size of the colloidal particles, and increased with the increase of the grain size. Under the conditions of the experiments the size of the colloidal particles could be determined from the depolarisation factor. If the particles are sufficiently small, the Tyndall light is completely polarised. The depolarisation factor was found to be zero for colloidal rubber solutions, mastic, arsenic trisulphide and cerium dioxide. The particles of these sols were practically spherical. The depolarisation factor showed great deviation from zero for sols of iron oxide, aluminium hydroxide and vanadium pentoxide. These particles differ widely from spheres. F. J. B.

1558. Depolarisation and Absorption of Light by Colloidal Gold Solutions. B. Lange. *Zeits. f. phys. Chem.* 132. 1–2. *pp.* 27–46, *Feb.*, 1928.

A series of solutions of colloidal gold with particles varying in size from 6 to 160 $\mu\mu$, and the absorption of light by these solutions was measured. Care was taken to ensure that the solutions contained the purest possible gold, free from gold oxide. The absorption constant agreed over a considerable range with that calculated from the theory of Mie, on the assumption that the particles were spheres. The absorption of light by the gold sols reached a maximum for medium particle size. The mean diameter of the particles, determined from the light absorption, agreed with that obtained from the velocity of sedimentation. A microanalytical method of estimating the gold oxide present in gold sols was developed. In a phosphorus-gold sol the amount of aurous oxide was 1·26 %. F. J. B.

1559. Magnetic Rotatory Dispersion of Methyl and Propyl Alcohols. D. O Jones and E. J. Evans. *Phil. Mag.* 5. *pp.* 593–608, *March*, 1928.

The magnetic rotatory power of methyl alcohol over the range from 0·4379 to 0·2600 μ is given by

$$\phi = n\delta\lambda^2 = 1{\cdot}190\left\{\frac{\lambda^2}{\lambda^2 - 0{\cdot}1100^2}\right\}^2,$$

where δ = Verdet's constant, n = the refractive index of the liquid for wave-length λ. For ethyl alcohol and for a sample of propyl alcohol containing an optically-active impurity the corresponding constants are 1·444 and 0·1114, 1·553 and 0·1138. The magnetic rotations can, therefore, be represented by a formula involving only one free period, and giving values for Verdet's constant in agreement with Perkin's values for sodium light. The corresponding wave-lengths of the absorption bands are, however, only about one-half of those deduced by V. Henri from measurements of absorption, namely, 0·2207, 0·2231 and 0·2273 μ. The conclusion is drawn that these bands do not contribute materially to the magnetic rotation of the alcohols. The calculated ratios $\delta_{4359}/\delta_{5461}$ are about 0·6 % higher than those determined experimentally by Lowry. [See Abstract 1717 (1927).] T. M. L.

1560. Influence of Temperature on Optical Rotatory Power. R. Lucas. *Comptes Rendus*, 186. *pp.* 857–859, *March* 26, 1928.

The hypothesis that variations of rotatory power are due to the existence of two discontinuous configurations of the molecule leads to the formulæ

$$n_A = n_0 e^{-W_A/RT}, \quad n_B = n_0 e^{-W_B/RT},$$

where n_A n_B are the concentrations of two forms A and B at an absolute temperature T, and W_A W_B are their internal energies; K is the molecular gas-constant R/N. The variations of rotatory power with temperature are then given by

$$\alpha = \alpha_A \frac{m + e^x}{1 + e^x},$$

where $\alpha_A/\alpha_B = m$ and $\dfrac{W_B - W_A}{KT} = \dfrac{\delta W}{KT} = x.$

The curve obtained by plotting α against T will have an inflexion at a temperature $T = \delta W/2{\cdot}4K$, *i.e.*, at 300 Å. for a difference of energies of 1500 cal. per grm.-molecule, but it cannot have either a maximum or a minimum, since these only become possible in a system containing three forms, A, B and C. The author is thus led to postulate the existence of three forms of ethyl tartrate, in agreement with his previous deductions from the rotatory dispersion of this compound. T. M. L.

1561. Theory of the Kerr and Faraday Effects in Gases. Part II. Quadratic Effects. R. de L. Kronig. *Zeits. f. Phys.* 47. 9–10. *pp.* 702–711, 1928.

Continuing the investigation of earlier papers [see Abstracts 888 and 889 (1928)], the expansions for the differences of the two refractive indices of a gas in a magnetic or electric field are now carried on to the term in the square of the field intensity. For a diatomic gas with permanent electric moment and electronic impulse moment about the nuclear line, the quadratic longitudinal Kerr and Faraday effects are zero. The transverse effects exist and are examined in detail for the case when the incident frequency is far removed from those of the absorption bands. The conclusions of Part I referring to the linear Kerr effect are reconsidered, and it is now laid down that in no case are linear Kerr effects to be anticipated. A general comparison of the theory with experiment is given in a final section. W. S. S.

1562. Corpuscular Theory of Light and Gravitational Shift. G. Y. Rainich. *Phys. Rev.* 31. *pp.* 448–452, *March*, 1928.

Usually the prediction of spectral shift in the light coming from regions of higher gravitational potential is derived by considering the emitting atom as an oscillating mechanism, and the shift is connected with retardation of clocks. In this paper the question is considered from the point of view of the corpuscular theory of light in the form which it takes in the relativity theory. In the special theory the light ray is considered as given by a vector freely movable along the line of its direction. It follows that all rays of light are absolutely equal; the difference in colour is due to the difference in position with respect to the reference system (Doppler effect). In the general theory, motion of a vector along a curve leads to a geodesic; colours of different rays cannot be compared unless some universal time is introduced; this introduction is easy in the centro-symmetric case; in this case the discussion is completed and leads to the usual result. AUTHOR.

1563. Studies in Laminar Diffraction. Part I. Colours of Mixed Plates. I. R. Rao. *Indian Journ. Phys.* 2. *pp.* 167–176, *Jan.* 31, 1928.

The author classes as laminar diffraction effects those phenomena which are observed when light is incident on a thin sheet of transparent material bounded by straight or curved edges. The observed effects are determined by the thickness of the lamina and the fine structure of its edge. The mixed plate is made by rubbing saliva or white of egg between two thick, fairly plane glass plates. Circular bubbles form in the liquid. The author found (1) that the intensity of the light diffracted by the edges of air bubbles constituting the mixed plate is very unsymmetrical, and the asymmetry is explained; (2) that the diffracted light is coloured on both sides, the colours depending upon the angle of diffraction and the thickness of the mixed plate; (3) that the rings seen round a source of light observed through a mixed plate placed close to the eye are due to these colours; (4) that a microscopic examination of the mixed plate shows that the edges appear double on both sides; and (5) that the light diffracted on the fainter side is strongly polarised. The various effects are explained by a study of the wave front through the plate. R. S. R.

1564. Scattering of Light by Individual Particles in Smokes. H. P. Walmsley. *Phys. Soc., Proc.* 40. *pp.* 54–56, *Feb.*, 1928.

Applying the expression given by Maxwell for the number of collisions that occur between two sets of spherical uncharged molecules in a gas to the case of a smoke whose particles cover a wide range of sizes, it appears that particles of a given set collide less frequently with themselves than with those in sets of much larger or much smaller size. If the particles unite on contact, one would expect, therefore, that the units of the resulting aggregates would differ greatly in size. As this result is at variance with the deductions of Patterson and Whytlaw-Gray [see Abstract 977 (1927)] from experimental data, the validity of their argument is discussed. AUTHOR.

1565. Light-Scattering in Liquids at High Temperatures. S. R. Rao. *Indian Journ. Phys.* 2. *pp.* 179–193, *Jan.*, 1928.

Variations of intensity and depolarisation factor of the transversely scattered light with temperature studied in octane, carbon tetrachloride, ethyl acetate, benzene, chlorobenzene, and toluene; the depolarisation factor diminishes with temperature, at first slowly and later rapidly, until the fall becomes less rapid as the critical temperature is approached. Molecular anistropies are calculated; the anisotropy-temperature curves for the paraffin hydrocarbons show a remarkable and progressive change in their general shape with increasing length of the molecule; the curves for the esters are generally similar to one another; toluene resembles benzene, but its curve ascends above that of chlorobenzene, crossing the latter at 54° C.; in all cases the anistropy increases with the temperature, and tends to assume the value for vapour. A. D.

1566. Theory of Light-Scattering in Liquids. C. V. Raman and K. S. Krishnan. *Phil. Mag.* 5. *pp.* 498–512, *March*, 1928.

It has been shown that anisotropic gas molecules cause transverse scattering of light and imperfect polarisation [see Abstract 664 (1918)] and other effects. In the case of dense fluids the scattering may be satisfactorily explained, and a general theory of light-scattering in fluids has been worked out, which is applicable to polar and non-polar molecules [see Abstracts 892 and 893 (1923)]. There is apparently a considerable diminution in the optical anistropy of the molecules of a given substance as it passes from the condition of vapour to that of liquid, and a corresponding change occurs in the electric double refraction of the substance on change of state. The fact that the diminution is quite as marked in non-associated liquids as in associated liquids necessitates a revision of the theory. In the present theory it is assumed that the molecules are polarisable differently along three perpendicular axes which are fixed in the molecule. Further, in a liquid there exists, in addition to the external field, another field due to the doublets induced in the surrounding molecules—the polarisation field. In the usual treatment of the optical properties of a liquid, the polarisation field acting on a molecule is assumed to be independent of its orientation in the field. This assumption is not generally justifiable. On this basis an expression has been obtained for the intensity of scattering which is found to be in close accord with facts. [See also Abstract 79 (1926).] G. E. A.

1567. Lignose Colour Process. J. Rowatt. *Phot. J.* 68. *pp.* 104–105, *March*, 1928.

An account of a demonstration of this process. A. D.

1568. Rate of Desilverisation of the Wet Collodion Silver Bath. B. P. O'Shaughnessy. *Phot. J.* 68. *pp.* 123–126; *Disc.*, 126–127, *March*, 1928.

The experimental results given show that the readings of the argentometer, although they may be correct for a solution of silver nitrate, do not indicate the absolute amount of silver nitrate in a sensitising bath in use; this may be ascertained only by chemical determination. The amount of silver nitrate used per unit area of plate during sensitisation depends to a certain degree on the personal equation of the individual worker. The discrepancy between the argentometer reading and the absolute amount of silver nitrate present at any given stage is greater in the dipping bath, where evaporation is reduced to a minimum, than in the open bath. T. H. P.

1569. Optical Sensitising of AgI. K. Baukloh. *Zeits. f. wiss. Phot.* 25. *pp.* 233–262, *March,* 1928.

A film of pure AgI on silver (daguerreotype fashion) can be optically sensitised by different dyestuffs. The sensitiveness is spread almost equally over the whole visible spectrum. AgI-gelatine films act like pure AgI films. Old AgBr-gelatine films are highly sensitised by being transformed into AgI-gelatine films; this down to the extreme red. This is traced to Hg vapours, which sensitises both AgBr and AgI, the former less so. A. D.

1570. Photographic Exposure. L. Silberstein. *Kodak Research Lab., Comm. No.* 336. *Phil. Mag.* 5. *pp.* 464–489, *March,* 1928.

After all, the quantum theory breaks down; there is no possible form of the distribution function $f(\epsilon)$ which would give a faithful representation of the experimental findings. The author investigates the implications of different nuclear theories of exposure, with their assumptions and concepts. These are successively discussed and rejected, until the speck theory, coupled with an assumption that the rate of growth is proportional to the instantaneous *size* of the nuclei, is found to give more promising results on comparison with the known and certain new experimental data. The number of fog-grains is, however, in two cases still much too large. A refinement of the main formula for the number of grains affected by a given exposure is suggested and discussed. A. D.

1571. Carbro Process. F. J. Tritton. *Phot. J.* 68. *pp.* 159–161, *April,* 1928.

Explanation and practical demonstration of the Carbro three-colour transfer process. A. D.

1572. Broadening of Star Spectra for Photography. B. Meyermann. *Zeits. f. Instrumentenk.* 48. *pp.* 104–105, *March,* 1928.

Describes apparatus for producing a broadening of known and definite amount in the spectrum produced by a star image on a photographic plate. A mechanical device ensures that each part of the spectral band shall be equally exposed. J. W. T. W.

1573. Spectrophotometer for Technical Use. Freda Herzfeld-Hoffmann. *Zeits. f. Instrumentenk.* 48. *pp.* 105–108, *March,* 1928.

Describes a form of spectrophotometer suitable for use in a works laboratory for the control of production. The optical system is identical with that of the Koenig-Martens spectrophotometer. The arrangement of the parts is such as to facilitate the insertion, before one or both slits, of coloured media and particularly chemical solutions of which it is desired to find the transmission factor at various parts of the spectrum.

J. W. T. W.

1574. New Registering Photodensitometer. E. A. Harrington. *J.O.S.A. and R.S.I.* 16. *pp.* 211–222, *March,* 1928. *From the Nat. Bureau of Standards of the U.S. Dept. of Commerce, Paper No.* 15 *of the Portland Cement Assoc. Fellowship*

A direct-reading, self-recording densitometer with single thermocouple and low-resistance d'Arsonval galvanometer has been constructed and used to measure the relative opacities of the photographic images of the lines in ordinary spectra and in X-ray powder photographs. By suitable gearing to an electric motor the photographic negative is given a slow motion at right angles to a beam of light passing through a horizontal lens system; and at the same time a drum carrying photographic paper, on which a spot of light from the galvanometer is focussed, is caused by the same motor to rotate at such a rate that a certain distance on the drum corresponds to a certain distance on the negative. A permanent record of the true distribution of opacities is thus obtained, since the deflections of the galvanometer are inversely proportional to the opacities on the negative. Preliminary experiments show that the apparatus is dead beat and quick in response, and that it is sensitive, stable and accurate. AUTHOR.

1575. Rapid-Motion Photography in Aerodynamics. A. Klemin. *Mechanical Engineering,* 50. *pp.* 217–220, *March,* 1928.

Describes the methods used in the Japanese Aeronautical Research Institute for the study of problems in aerodynamics by the use of high-speed kinematograph photography. Pictures are obtained at rates up to 3000 per second. At frequencies up to 1200, the photographs are taken by the light of periodic sparks of short duration, obtained from a high-frequency generator. At the higher frequencies, the image to be photographed is reflected from the polished facets of a thin steel disc similar to a turbine disc. It is suggested that the methods might be applied in ballistic work. Examples of the photographs obtained are reproduced in the paper. J. W. T. W.

1576. Deviation from Lambert's Law for Tungsten and Molybdenum. C. Zwikker. *K. Akad. Amsterdam, Proc.* 30. 8. *pp.* 853–859, 1927.

The author finds that the emission from incandescent tungsten at oblique angles differs less from that at small angles from the normal than was found by Worthing [see Abstract 392 (1912)]. Curves of emissivity at all angles are given for tungsten in various states of polish and for molybdenum. The author finds that the ratio of the mean spherical candle-power of a tungsten filament to the mean horizontal candle-power differs from the theoretical value 0·785 by less than 1 %. In the final section of the paper the deviation from Lambert's law exhibited by the two polarised components of the emitted light are studied. From the results obtained it is possible to calculate values for m, the refractive index, and x, the coefficient of extinction. The results are as follows :—

Tungsten, single crystal	$m = 2{\cdot}96$	$x = 3{\cdot}36$
Tungsten, small crystal	2·90	3·35
Molybdenum, small crystal	3·75	4·25

The normal emissivity is for tungsten 0·44 and for molybdenum 0·37.

J. W. T. W.

1577. Investigation of the Variations of Light Intensity from Self-Regulating Direct-Current Arc Lamps. A. Graf. *Zeits. f. tech. Phys.* 9. 2. *pp.* 60–64, 1928.

A description of an experimental method for the registration of the intensity of the arc over long continuous periods of time. A full description of the method used is given, as well as diagrams of actual records and the layout of the apparatus. The results show that in a self-regulating, direct-current arc lamp the arc intensity varies from 1 % to 8 %. The intensity variations were at a minimum for the Weule arc lamp at 15 amperes (2·5 %), and this is the best current strength for constant intensity for this type of lamp. The 30-ampere Körting-Mathiesen arc lamp gave about 1·3 % and the 8-ampere 5·3 % variation in light intensity. S. G. B.

1578. Luminosity of Flames Containing Sodium Vapour. G. L. Locher. *Phys. Rev.* 31. *pp.* 466–469, *March*, 1928.

For concentrations of sodium vapour varying from 1 to 10,000 in arbitrary units, the luminosity of a sodium flame is found to be proportional to the square root of its thickness, except for the very low concentrations, where it is more nearly proportional to the first power of the thickness. This is in general agreement with the work of Gouy. The amount of light from a fixed amount of metallic vapour uniformly distributed in a flame of variable thickness is independent of the concentration of the vapour. The combined luminosity of two flames in tandem is approximately proportional to the square root of the total mass of metal in the flames; this indicates that the luminosity of a flame is independent of the distribution of the emitting vapour in it. AUTHOR.

1579. Emission of Phosphorescence. Part II. Investigation of the Bands in the Samarium Sulphide Spectrum. R. and Henriette Tomaschek. *Ann. d. Physik*, 84. 8. *pp.* 1047–1073, *Jan.* 13, 1928.

A continuation of the authors' work on the samarium spectrum [see Abstract 335 (1928).] It is noted in the previous work that the samarium spectrum obtained from material of a particular kind is more potent than that obtained when other fundamental materials form the basis of the containing substance. The present paper raises the point as to which fundamental material containing samarium is best for the examination of the spectrum and affords a comparison of the spectra of various phosphorescent mixtures containing samarium sulphide. As a result of a large number of experiments with oxides, fluorides, and sulphides, partly mixed together and partly mixed with sulphides, it is shown that the best medium for good results is given by a mixture containing CaS and SrS. Experimental details, tables of results and plates showing spectra at various temperatures are appended.

Note on Above Paper by M. Travniček. *Ann. d. Physik*, 85. 5. *pp.* 645–646, *March* 19, 1928.

The author of the note wishes to clear up any misunderstanding of his statement regarding the use of phosphorus, and thereby necessitating a less amount of sulphur. There will be a further paper, which will completely clarify the author's meaning. S. G. B.

1580. Radiation in an Enclosed Space and the Hypothesis of Light Quanta. L. Rosenfeld and E. E. Witmer. *Zeits. f. Phys.* 47. 7–8. *pp.* 517–521, 1928.

De Broglie has assumed that light quanta can act on one another like the particles of a gas, and the authors examine the theoretical properties of a "light quanta gas," assuming that the light corpuscles are capable of exchanging energy and impulse when they collide with one another;

deals with the statistics of the gas, and shows that the equations governing equilibrium differ when the number of quanta in unit volume is constant and when it can vary; the latter case corresponds to "black" radiation. If a hollow space with reflecting walls contains, in addition to the quanta, a small particle of matter with which they can react, this particle behaves as a reservoir for light quanta, which are absorbed and emitted by it in turn. Even if the particle is one with a line spectrum, the final effect will be to bring the whole radiation in the space into the state of black radiation. The system may be called a "light quanta vapour." The new theory is compared with the old as regards the conception of the temperature of a space containing radiation. An experiment to render evident the interaction between light quanta is suggested in which a beam containing several distinct frequencies is brought to a focus by an achromatic lens and then into a spectroscope. If the effect were large enough, a faint continuous spectrum would be seen in addition to the original line spectrum. H. N. A.

1581. Refraction in Gases. M. Rusch. *Ann. d. Physik*, 85. 5. *pp*. 581–586, *March* 19, 1928.

Correction of and supplement to a former paper [see Abstract 1374 (1923)]. All three dispersion constants vary unmistakably with the region from which they are derived. A. D.

1582. Measurement of Radiant Energy by Means of the Maxwell-Bartoli Forces. B. del Nunzio. *Ann. R. Scuola Ing., Padova*, 3. *pp*. 35–43, *March*, 1927.

Some questions in the energetics of optics possessing theoretical and technical interest have not been solved owing to the lack of an instrument capable of measuring directly and accurately the energy contained in a bundle of rays. Radiometric and thermokinetic actions have been brought in with this object, and interesting results have been obtained, especially as regards phenomena occurring at very low pressures. The author has had recourse to the pressure of radiation (called also the Maxwell-Bartoli force) and in this paper explains the method and form of apparatus used—that of A. Amerio. First a relative verification of the direct proportionality between the pressure and the density was made, and then an absolute verification by measuring at the same time the torsion couple of the suspending thread of the movable arrangement subjected to the radiation and the total incident energy. The sources of error are considered, and the author intends continuing the research commenced.
J. J. S.

1583. Explanation of the Green Ray. F. Ruda. *Accad. Lincei, Atti*, 6. *pp*. 152–156, *Sept*., 1927.

Whereas on theoretical grounds the duration of the green ray in the latitude of Florence at the period of the equinox should not exceed one second, previous investigators, and notably Guglielmo and Julius, have observed that it may last for two seconds. To explain this discrepancy Julius proposed the hypothesis that in the vicinity of the horizon the atmosphere produces an anomalous dispersion of sun light for the luminous rays comprised between the Fraunhofer lines E(526·97 $\mu\mu$) and F(486·06 $\mu\mu$), in particular for the waves round about 530 $\mu\mu$, this being the wave-length corresponding to the light of the green ray. According to Julius, this anomalous dispersion is due to the presence in the aforesaid spectral zone of telluric absorption lines produced by the free ions in the upper strata of the atmosphere. Two important facts contradict this hypothesis: first, the absence of data concerning the appearance of such lines in the green zone of the solar spectrum when the sun is very close to the horizon, and secondly, the negative results of Guglielmo's experiments [*Accad. Lincei, Atti*, 25. p. 296 (1916)]. If the free ions produce characteristic absorption lines for the green light of a wavelength in the vicinity of 530 $\mu\mu$, there should also occur in the vicinity of these lines marked variations in the refractive index of the air for wavelengths immediately above and below those of the absorbed waves. It follows from this that the refractive index of air wanting or poor in ions should differ sensibly from that of air rich in ions, at least for the spectral zone in the vicinity of that wave-length. This was tested experimentally. The method adopted consisted in observing, by means of an eyepiece provided with a grating, the fringes obtained in a Jamin interferometer, while the air traversed by one of the interfering bundles of rays was ionised by X-rays. If ionisation alters the refractive index a shifting of the fringes should have been observed, but none was detected. The experiments, which are described in detail, tend to prove that whether the air be ionised or not its refractive index remains unchanged. E. F.

1584. Explanation of the Green Ray. F. Ruda. *Accad. Lincei, Atti*, 6. *pp*. 228–230, *Oct*., 1927.

The results of the experiments described in a previous paper [see preceding Abstract] appear to justify the conclusion that the phenomenon is due to atmospheric refraction without the intervention of anomalous dispersion. As to the changes in colour from green to blue recorded by Guglielmo in numerous observations at sunrise and sunset, they may be attributed to the variable dimensions of particles in suspension, especially in the lowest atmospheric strata. The divergence in certain cases between the theoretical and the actual duration of the phenomenon is further elucidated by an explanation which has been suggested to the author by Giorgi and is a natural consequence of the theory of colour vision recently published by him and Miss Rosati (*Nuovo Cimento*, 4. p. 27, Feb., 1927). When the sun sets, after the disappearance below the horizon of the dazzling white image a coloured zone will be visible in which are superposed the yellow, green, azure, blue, ultramarine and violet images. These compounded radiations produce in the eye a green effect which is a visual, not a spectral, green. Consequently the observer may experience the sensation of green light before the monochromatic arising from the green image reach the horizon. Thus the duration of the green ray will be not one second, as was previously calculated from the duration of the spectral green, but at least twice as long. This would appear to furnish a satisfactory explanation of the phenomenon. E. F.

1585. Demonstration of the Pressure of Light. J. Plotnikov. *Indian Journ. Phys.* 2. *pp*. 177–178, *Jan*., 1928.

The pressure of light may be demonstrated by means of a T-shaped evacuated vessel containing powder of *lycoperdon bovista*. The tube is tuned so that the top of the tee is vertical and the upright is horizontal. A very powerful beam of light (for example, from a high-intensity arc)is directed along the horizontal portion of the vessel, and as the powder falls in the vertical portion it is seen to be deflected by the light beam. The effect can be shown to a large audience by projecting the shadow of the vessel on to a screen. J. W. T. W.

1586. Principal Series of Potassium. F. Rasetti. *Accad. Lincei, Atti*, 6. *pp.* 503–505, *Dec.* 4, 1927.

Determination of the number of dispersion electrons for the first two lines of the 4^2S-m^2P series of potassium. Trumpy's law, that the coefficient a_{ik} of probability of passage from the states mP to the state S decreases as $1/m^3$, is not confirmed for these first two lines; it is valid for high terms. A. D.

1587. Structure of the Fluorine Spectrum (F.I.). T. L. de Bruin. *K. Akad. Amsterdam, Proc.* 30. 9–10. *pp.* 944–951, 1927.

In a former paper [see Abstract 1375 (1927)] the author has deduced, from the measurements of Gale and Monk and the observations of Carragan of the Zeeman effects, six multiplets in the F.I. spectrum, including most of the observed strong lines. The theoretical term scheme of F.I. is now discussed on the basis of the theory of complex spectra due to Heisenberg, Pauli, and Hund. The satisfactory agreement between the experimental and theoretical terms is also examined and interpreted. A comparison is given with the spectra NI and OII. H. H. Ho.

1588. Resolution of an Absorption Band Regarded as Common to Praseodymium and Neodymium. L. Fernandes. *Accad. Lincei, Atti*, 6. *pp.* 413–417, *Nov.* 20, 1927.

At a temperature approaching that of liquid air, the line of wavelength 469 Å. of the absorption spectra of praseodymium and neodymium is resolved into thin sharp lines, the intensities and wave-lengths of these differing considerably with the two metals. T. H. P.

1589. Choice of Spectral Lines for Metrology. A. Pérard. *Rev. d'Optique*, 7. *pp.* 1–27, *Jan.*, 1928.

The wave-lengths of the lines examined have been compared with the red line of cadmium by means of the Michelson interferometer with path differences up to 202 mm. Curves are given of the differences between the observed fractional excess in order of interference and that calculated from the mean wave-length. The principal aim is to make complex lines available for metrology as well as those which are simple and symmetrical. Among the rays studied are 4358, 4916, 5461, 5770 and 5791 Å. of Hg; 5852, 5882, 5945, 6096 and 6402 Å. of Ne; 4471, 5016, 5876 and 6678 Å. of He; 5570 and 5871 Å. of Kr; 4624, 4671 and 4734 Å. of Xe; 4662, 5086, 5155 and 6438 Å. from the Hamy Cd lamp and 5086 Å. from the Michelson Cd lamp. F. S.

1590. Wave-Lengths in the Nitrogen Peroxide Absorption Spectrum. Lois C. K. Carwile. *Astrophys. J.* 67. *p.* 184, *March*, 1928.

1591. Residual Rays ("Reststrahlen") in the Visible Spectral Region. G. Joos. *Phys. Zeits.* 29. *pp.* 117–118, *Feb.* 15, 1928.

The conditions necessary for the production of residual rays in this region are discussed, and it is concluded that salts of the transition elements Sc to Cu are most likely to show the phenomenon. The absorption spectra of some chromium double salts of the alum type have been investigated and some constant frequency differences found. The corresponding residual rays would, however, lie at 232 μ, and have not yet been observed. F. S.

1592. Origin of the Spectrum of the Glow of Phosphorus. H. J. Emeléus and R. H. Purcell. *Chem. Soc., J. pp.* 628–630, *March*, 1928.

The ultra-violet spectrum measurements for the discharge through phosphorus pentoxide [see Abstract 2278 (1927)] correspond below 3000 Å. with the bands of the singly ionised oxygen molecule observed by Johnson [see Abstract 2769 (1924)]. The complex band at 3200–3400 Å. is not, however, found in the oxygen spectrum, but at shorter wave-lengths there is close agreement both in the measurements of the main band heads and in their intensities. The oxygen was probably formed by dissociation of the pentoxide. The production of ionised oxygen is thermochemically possible, since the heat evolved in the reaction $2P + \frac{5}{2}O_2 = P_2O_5$ has the remarkably high value 370 cal. and the ionisation potential of oxygen is about 16 volts, which is equivalent to 370 cal. It appears that the origin of the spectrum of the glow of phosphorus must be regarded as unsettled, solution of the problem requiring a more accurate and extensive knowledge of the spectra concerned than is yet available. T. H. P.

1593. Wave-Lengths in the Arc Spectrum of Chromium in International Units. D. Foster. *Astrophys. J.* 67. *pp.* 16–23, *Jan.*, 1928.

The wave-lengths of 277 chromium lines, in the region to the violet of λ4352, are given. The errors in the wave-lengths are not larger than a few thousandths. A convenient source is described. AUTHOR.

1594. Arc Spectrum of Carbon. A. Fowler and E. W. H. Selwyn. *Roy. Soc., Proc.* 118. *pp.* 34–51, *March* 1, 1928.

The authors have made further observations of the spectrum of CI, using an oxide of carbon in helium, as in Merton and Johnson's experiments; a number of new lines have been observed, some of which are not as yet classified. The terms predicted by the Heisenberg-Hund theory are similar to those for NII and OIII; a table gives the symbols for these terms and the positions of the electrons corresponding to them. The deepest term is a triplet P_0, the value of which is estimated at 91017, corresponding to an ionisation potential of 11·2 volts. Another table gives the observed triplet combinations, showing their relations to the terms; there is a similar short table of singlets. Considerable difficulty exists here, for there are no extended series and many of the expected lines are in the near infra-red or the Schumann region and have not been observed. A long table showing the relation between the terms of OIII, NII and CI is given, and shows the close similarity which exists and is to be expected from the theory. Each of the atoms involved has six external electrons, but the nuclear charge is 8 for OIII, 7 for NII and 6 for CI. A regular progression in most of the term values when passing from OIII to CI is clearly shown, though certain terms of CI must for the present be regarded as anomalous. H. N. A.

1595. Spark Spectrum of Silver (AgII). A. G. Shenstone. *Phys. Rev.* 31. *pp.* 317–322, *March*, 1928.

The spark spectrum of silver can be based on a set of terms as follows: ^{3}D, ^{1}D from the structure $4d^95s$; $^{3\&1}$P, D′, F from $4d^95p$; ^{3}D, ^{1}D from $4d^96s$; $^{3\&1}$S, P′, D, F′, G from $4d^95d$. The theoretically lowest term $^1S_0(4d^{10})$ has not been found, but an estimate of its position is given. There is evidence also for the structure $4d^94f$. All terms have intervals very different from the Landé values. The *g*-values also are evidently very irregular. The separate limits calculated from the ^{3}D, ^{1}D series of two members show the same apparent divergence from theory as in CuII, NiI, PdI. The intervals in the set $4d^95d$ also indicate divergence from theory. The calculated ionisation potential is 17·1 volts from $5s^3D_3$.

AUTHOR.

1596. Absorption Spectra of Formaldehyde Solutions. S. A. Schou. *Comptes Rendus*, 186. *pp.* 690–692, *March* 12, 1928.

Auerbach and Barschall have shown that formaldehyde in aqueous solution is polymerised and hydrated. The absorption spectrum is now shown to confirm the above result, no absorption being shown in the region of the carbonyl band even for a 12-molar aqueous solution at a thickness of 60 mm., so that less than 1/1200 of the molecules are present as monomolecular HCHO. Non-aqueous solutions of formaldehyde must be examined below − 21°, otherwise polymerisation takes place. Data are given for solutions in hexane and also for gaseous formaldehyde, in which it is found that monomolecular formaldehyde absorbs in the same region as acetic and propionic aldehydes, *viz.*, maxima at $\lambda = 2934$ Å. and $\lambda = 2900$ Å. [see Abstract 1795 (1926).] Whilst the vapour bands possess a fine structure corresponding to a quantified rotation of the molecule, the solution spectrum is continuous and the rotation no longer quantified. The explanation given is that the interval between two collisions of the formaldehyde molecule and the solvent molecules is shorter than the period of molecular rotation.

H. H. Ho.

1597. Absorption Spectra of Photoelectric Alkali Halides. R. Ottmer. *Zeits. f. Phys.* 46. 11–12. *pp.* 798–813, 1928.

The primary photoelectric current is not observed in pure alkali halides, but appears when crystals of these substances are discoloured by light, heat, or corpuscular rays. The author investigates the absorption spectra of alkaline chlorides, bromides, iodides, and fluorides, and indicates the probability of the colouring being due to neutral alkali atoms caught in a space-lattice consisting of ions. A special study is devoted to the secondary maxima of the absorption spectra in the red, which might be traced to larger aggregations of alkali atoms, but no definite conclusion is arrived at.

E. E. F. d'A.

1598. Alkaline Earth Halide Spectra. O. H. Walters and S. Barratt. *Roy. Soc., Proc.* 118. *pp.* 120–137, *March* 1, 1928.

It has been found that the band spectra can be observed in absorption when the metal is heated in excess with the halide salt. Data are given for CaF, CaCl, CaBe, CaI and corresponding subhalides of Si, Ba and Mg. The λ5292 band of CaF has been investigated under a dispersion of 5 Å. per mm., the structure being very different in emission and absorption. New groups have been found in the ultra-violet with other halides. It is shown that molecules of the type MX exist in the vapour state at 1000° C. in equilibrium with the metal and normal salts. F. S.

1599. Vibrational Levels and Heat of Dissociation of Na_2. F. W. Loomis. *Phys. Rev.* 31. *pp.* 323–332, *March*, 1928.

According to Kemble's theory of the Zeeman effect in band spectra, there should be a magnetic rotation line at the head of each Na_2 absorption band. It is found that most of Wood's magnetic rotation lines in the blue-green region can be arranged into a band system, and integral vibrational quantum numbers, n' and n'', assigned, in terms of which their frequencies are given by the following polynomial:—

$$\nu = 20301{\cdot}7 + (124{\cdot}13n' - 0{\cdot}84n'^2) - (158{\cdot}5n'' - 0{\cdot}73n''^2 - 0{\cdot}0027n''^3).$$

The heat of dissociation is then calculated to be $1{\cdot}0 \pm 0{\cdot}1$ volt. The energies needed to dissociate the molecules which correspond to the upper levels of the blue-green and red systems are shown to be 0·6 volt and 1·25 volt respectively, within about 0·1 volt. The lower level molecule, in both systems, dissociates by vibration into two normal (3^2S) atoms, while the upper level molecule, in both systems, dissociates into one atom in the normal state and one in a 3^2P state. When the intensities of the magnetic rotation lines corresponding to the heads are tabulated, in the usual square array, according to n' and n'', a wide open parabola-like figure appears, of a type which Condon has accounted for in terms of an hypothesis of Franck. This affords an explanation of a puzzling phenomenon, reported by Wood, in the spectral distribution of the fluorescent light when excited by light of various frequencies. AUTHOR.

1600. Width of the D Absorption Lines in Sodium Vapour. A. S. Fairley. *Astrophys. J.* 67. *pp.* 114–122, *March*, 1928.

Appropriate measurements of the width of the D-lines in absorption in sodium vapour under controlled conditions of temperature were made, over the range 180°–380° C., with a column of vapour 21 cm. long. Where the measured width was greater than 0·25 Å. the results roughly confirm J. Q. Stewart's suggestion that the widening is due to a cause analogous to "broad tuning," since the observed widths fit the formula he has derived from the classical theory of a "simple linear oscillator." Direct comparison between the artificial spectrum and the solar spectrum indicated that the solar (D) lines may be produced by a column of only about 4×10^{13} non-ionised sodium atoms per square centimetre in the solar atmosphere. AUTHOR.

1601. Intensity Ratio of the D-Lines. W. Lochte-Holtgreven. *Zeits. f. Phys.* 47. 5–6. *pp.* 362–378, 1928.

The probabilities of switches giving rise to the two D-lines are regarded as equal, but the relative numbers of atoms in the two excited states are regarded as being in the proportion of two to one. Hence, the intensity ratio of the D-lines is as two to one. But this ratio is observed under very different conditions of excitation—spark, flames, fluorescence, etc. The author investigates the conditions affecting the relative numbers of atoms in the two excited states by observing the fluorescence when sodium vapour is excited by the light of first one and then the other D-line, with different pressures of admixed argon, neon-helium, nitrogen, and hydrogen separately. It is possible to distinguish between collisions which cause a switch from the excited state to the other excited state, and from the excited state to the normal state. Collisions with other Na or K atoms are of the order of two hundred times as effective in causing a switch from one excited state to the other as collisions with inert gases. A. C. M.

1602. Intensities in the Spark Spectrum of Oxygen. W. R. van Wijk. *Zeits. f. Phys.* 47. 9–10. *pp.* 622–626, 1928.

Ornstein and Burger [see Abstract 1751 (1927)] applied the intensity rules to singlet-triplet systems and their intercombinations, and found them valid; also they were led to regard the two systems as really one. This is now extended to the doublet-quartet system of OII; in three multiplets classified by A. Fowler the rules give intensities in good agreement with the observed values. A. C. M.

1603. Line Spectrum of Oxygen. C. Mihul. *Ann. de Physique,* 9. *pp.* 261–380, *March–April,* 1928.

The spectra from 7000 Å. to 2050 Å. have been investigated by means of a concave grating of 3 m. radius and by prism spectrographs. The lines of different orders (OII and OIII) have been separated by varying the conditions of discharge, applied to the tubes, while sharp and diffuse lines have been separated by changes of pressure. Tables are given of 428 lines of OII and of 315 lines of OIII. The Zeeman effect of 111 lines of OII and of 19 lines of OIII has been studied, improvements in applying Geissler tubes to the poles of an electromagnet having been made. In the spectrum of OIII, 112 lines have been classified. The terms of the OII spectrum corresponding to the 3*d* orbit have been found, and in addition combinations between a system of quadruplets and one of doublets. F. S.

1604. Wave-Lengths in the Secondary Spectrum of Hydrogen. H. G. Gale, G. S. Monk and K. O. Lee. *Astrophys. J.* 67. *pp.* 89–113, *March,* 1928.

With a specially constructed tube as a source, wave-lengths of 3064 lines between 3394 and 8902 I.Å. were measured. Of these, 95 strong lines between 4171 and 6527 Å. were photographed by means of a Fabry-Perot interferometer and auxiliary concave-grating spectrograph, and the wave-lengths measured in comparison with neon lines. For 61 of these the probable error is 0·0012 or less; for none of them is it greater than 0·0035 Å. The secondary spectrum was then photographed with a 21-ft. concave grating in a Rowland Mounting, with a dispersion of 2·63 Å./mm. and a theoretical resolving power of 80,000 in the first order. The wave-lengths of the remaining 2969 lines were obtained wherever possible by interpolation between the 95 hydrogen lines measured with the interferometer. Where no such hydrogen standards existed, the spectrum of iron was used as a standard. The mean error of most of the lines thus measured is less than 0·01 Å. It is believed that many uncertainties due to lack of resolution in previous measurements of the spectrum have been eliminated. The measures show good agreement with those of Merton and Barratt and Allibone. The wave-lengths are systematically higher than Poettker's by about 0·24 Å. AUTHORS.

1605. Light Excitation through the Metastable Condition of the Rare Gas Atom. F. Paschen. *Preuss. Akad. Wiss. Berlin, Ber.* 29. *pp.* 207–213, 1927.

Experiments are described which were carried out with pure helium, neon and argon containing very slight admixtures of Al, Mg, Zn, Cd. The spectra are investigated (*a*) in the negative glow light of the hollow cylinder kathode, (*b*) in positive light. Quartz glass tubes are used. The kathode used is either a hollow aluminium or magnesium cylinder or a thin-walled carbon cylinder. Tables are given showing the results of each of the metals in the three gases and also of aluminium in neon glow light and in argon glow light. A. E. G.

1606. Structure of the Band Spectrum of Helium. Part IV. W. E. Curtis. *Roy. Soc., Proc.* 118. *pp.* 157–169, *March* 1, 1928.

Since the last paper [see Abstract 2288 (1925)] recent work, notably by Mulliken, has necessitated certain radical changes in notation, and an explanation of these is first given. Details of three new bands are given, having the same final electronic state (2P) as the three previously investigated. The new bands are situated near the following wave-lengths: λ6416, λ4558 and λ5885. The first two are near strong bands λλ6400 (3S → 2P) and 4546 (4S → 2P), and the evidence shows that in each case the weak new band arises from the vibration transition 1 → 1, the strong band being due to the vibrationless molecule. The third new band has its final state identical with that of the R′P branches of λ5730, *i.e.*, $2P_A(0)$. The electronic derivation of the initial state is uncertain, but the strength of the band indicates that it is vibrationless. The molecular constants of the molecule for the initial and final states are evaluated in accordance with the new interpretation, and are tabulated together with the suitably modified results of the earlier papers. A detailed discussion is given. W. S. S.

1607. Intensity Distribution in the λ4650 Band of Helium. W. H. J. Childs. *Roy. Soc., Proc.* 118. *pp.* 296–317, *March* 1, 1928.

A recent development [see Abstract 1386 (1927)] makes it appear probable that alternate lines are missing. These measurements have been made to provide comparison with predicted values. Five images of a continuous spectrum of increasing density were photographed on the same plate as the band, and measured by a selenium cell, optical photometer or Moll microphotometer. The predicted distribution is of the correct type, but the P and R branches are much stronger, relative to the Q branch, than theory indicates. It is found that an expression of the form $ie^{-E/kT}$, where i is a linear function of j, is adequate to describe the observed distribution. In a discussion of the temperature of the gas, a higher temperature is found for the Q branch than for the P and R branches. F. S.

1608. Regularities in the Spectrum of Ionised Neon. Part II. P. K. Kichlu. *Phys. Soc., Proc.* 40. *pp.* 41–45, *Feb.*, 1928.

In a previous paper on the same subject [see Abstract 107 (1928)], the author traced a system of quartet terms in the known spectrum of ionised neon. In the present paper the theory of Hund is applied in tracing doublet terms and intercombinations between doublets and quartets. Almost all the lines between 2500 and 3800 have been accounted for, with a few discrepancies. AUTHOR.

1609. Infra-Red Absorption Spectra of Acetylene, Ethylene and Ethane. A. Levin and C. F. Meyer. *J.O.S.A. and R.S.I.* 16. *pp.* 137–164, *March*, 1928.

The spectra of acetylene, ethylene and ethane have been investigated with gratings in the region between 2 μ and 15 μ. Each gas shows a more or less characteristic type of structure for its vibrational-rotational bands. The three main absorption regions of acetylene have been resolved into individual lines which are alternately intense and faint. These lines have the same average spacing in the three bands. The band at 13·7 μ shows a strong unresolved Q branch, while the bands at 7·5 μ and 3·0 μ lack evident Q branches. The two minor absorption regions of acetylene have also been investigated. The molecular moment of inertia has been computed from the spacing of the fine structure of the principal acetylene bands. The moment of inertia has also been computed from the classical theory on the assumption of a linear molecular model. The values obtained by the two methods are in agreement. For ethylene, seven regions of absorption have been investigated. Two of these have been resolved into individual lines, with a strong Q branch present in one case and absent in the other. Four of the remaining regions reveal envelopes of an identical type, which is characterised by a sharp Q branch together with P and R branches. The bands found in the region of 2·3 μ apparently lack Q branches. This latter group has been partially resolved. The main absorption regions of ethane reveal bands, each consisting of a single succession of absorption maxima. The spacing of these maxima is different for each of the bands, but the structure obtained is for the most part of a regular nature. AUTHORS.

1610. Absorption Spectrum of Cobalt Chloride. W. R. Brode. *Roy. Soc., Proc.* 118. *pp.* 286–295, *March* 1, 1928.

The absorption spectrum of cobalt chloride in concentrated hydrochloric acid has been investigated (*a*) visually with a Hilger-Nutting spectrophotometer, and (*b*) photographically with a Judd-Lewis photometer and Littrow spectrograph. The plates obtained in the latter method were read by means of a Moll microphotometer. The principal absorption band between 7500 Å. and 4400 Å. is shown to consist of seven similarly shaped bands of different intensities. There is a constant frequency difference between adjacent bands, and the frequencies of these component bands are integral multiples of this constant difference. There appears to be a relation between the odd and even numbered multiples and their relative intensities of absorption. F. S.

1611. Metallic Spectra Excited by Active Nitrogen. J. Okubo and H. Hamada. *Phil. Mag.* 5. *pp.* 372–380, *Feb.*, 1928.

According to Saha and Sur, "active nitrogen" is due to nitrogen molecules in an excited state, while Sponer maintains that it is due to neutral nitrogen atoms, which by collision with one another and another "foreign" atom can give up to the foreign atom energy corresponding to the heat of dissociation of the nitrogen molecule [see Abstract 546 (1926)]. The authors examine the spectra of the after-glow of metals excited by active nitrogen (mercury, cadmium, zinc, magnesium, sodium, potassium, thallium and calcium), and conclude that their results favour Sponer's theory. A. C. M.

1612. Fine Structure of Mercury Lines. W. H. McCurdy. *Phil. Mag.* 5. *pp.* 386–392, *Feb.*, 1928.

The fine structure of mercury lines appears to be different according to the conditions of the source. This is due to broadening and selfreversals of the components of the lines. The structures of the lines 3650 Å.U. and 2967 Å.U. were examined, using a Cooper-Hewitt mercury arc with water-cooled kathode, and the discharge could be thrown against the side of the tube by a magnetic field. Instead of nine components originally ascribed to the line 3650 Å.U., only five are now found, while there are six and not seven components to 2967 Å.U. A. C. M.

1613. Some Spectra of Mercury. M. Ponte. *Comptes Rendus*, 186. *pp*. 633–635, *March* 5, 1928.

Mercury vapour was excited by discharge from a single electrode in an intense high-frequency field. The electrode was of tungsten and the wave-length of the circuit about 10 metres. Twelve members of the $1^1P_1 - m^1D_2$ series and eleven of the $1^1P_1 - m^1S_0$ series were photographed in addition to ten members of the first spark spectrum. At a temperature of 150° C. a rich band spectrum was obtained, including several systems observed by Rayleigh and Stark, as well as some of longer wave-length which could not be identified. F. S.

1614. Emission of Light by Na-Flames; Absorption of Light by Hg-Vapour. H. A. Wilson. *Roy. Soc., Proc.* 118. *pp*. 362–366, *April* 2, 1928.

In 1859 Gouy found that the emission of light by flames containing sodium was approximately proportional to the square root of the amount of sodium per square centimetre when this is not extremely small. The author confirms this experimentally, and works out an explanation based on taking into account the absorption of the sodium light by the sodium vapour, the sodium atoms absorbing the light at the centre of the D-lines much more strongly than that at the edges. The same theory accounts for Hughes and Thomas's results on the absorption of resonance radiation by mercury vapour [see Abstract 339 (1928)]. The results appear to be consistent with the view that the atoms absorb light like simple damped oscillators. A. D.

1615. Zeeman Effect at Intermediate Strengths of Magnetic Field. K. Darwin. *Roy. Soc., Proc.* 118. *pp*. 264–285, *March* 1, 1928.

In a recent paper [see Abstract 2897 (1927)] C. G. Darwin has developed formulæ from which the frequencies and intensities of lines in the standard Zeeman effect can be found for all field strengths. Except for $s - p$ doublets, this could previously only be found for weak and strong fields. In the present paper the calculations are made for $s - p$ and $p - d$ doublets and for $s - p$ triplets, involving 10, 34 and 19 lines respectively. F. S.

1616. Zeeman Effect of Intercombination Lines. W. C. van Geel. *Zeits. f. Phys.* 47. 9–10. *pp*. 615–621, 1928.

Hönl [see Abstract 1411 (1925)] has formulated rules for the intensities of the Zeeman components of lines. The present experiment was performed to see if these rules were valid for intercombination lines, and the mercury line $\lambda 3663 \cdot 28 (p_2 D_2)$ was used. But for small discrepancies the rules held. A. C. M.

1617. Zeeman Effect in Band Spectra. R. de L. Kronig. *Phys. Rev.* 31. *pp*. 195–198, *Feb.*, 1928.

The peculiar intensities of the Zeeman components in the Ångström

CO bands, as described by Kemble, Mulliken and Crawford [see Abstract 362 (1928)], are explained by an application of perturbation considerations. It is found that an asymmetrical change in the intensities of the Zeeman components is predicted by this theory. A. C. M.

1618. Interpretation of Band Spectra. R. de L. Kronig. *Zeits. f. Phys.* 46. 11–12. *pp.* 814–825, 1928.

Hund's application of Schrödinger's theory [see Abstract 2222 (1927)] to the arrangement and combination of terms in band spectra dealt only with diatomic molecules in which the nuclei are equal; in this paper a consideration of the case of unequal nuclei leads the author to an arrangement of terms into two systems in a manner which he claims to be valid for the general case of the diatomic molecule. The treatment is largely mathematical, and includes a discussion of the Stark and Zeeman effects in band spectra. A. C. M.

1619. Precision Measurements of the K-Series of Rhodium. F. Enger. *Zeits. f. Phys.* 46. 11–12. *pp.* 826–832, 1928.

The new spectrometer of Siegbahn and Larsson [see Abstract 1772 (1927)] has been used to measure α_2, α_1, β_3, β_1, β_2, in the K-series of rhodium. The refractive index of calcspar for the measured wave-lengths has been calculated. A. C. M.

1620. Doublet Components of Hα in Absorption. L. S. Ornstein, F. Zernike and J. L. Snoek, Jr. *Zeits. f. Phys.* 47. 9–10. *pp.* 627–630, 1928.

The absorption of the components of Hα were studied, and found to be practically equal, the larger wave-length component being slightly more absorbed. The observations exclude the possibility of the 2^2S state being metastable. A. C. M

1621. Recent Applications of X-Rays. V. E. Pullin. *Journ. Sci. Instruments*, 5. *pp.* 41–47, *Feb.*, 1928. *Paper read before the Phys. and Optical Societies, Jan.*, 1928.

Work at the Royal Arsenal, Woolwich, was commenced during the late war for shell-base examination. This work has been greatly extended. Crystal analytical work in connection with explosives is now carried out. Similarly, the crystal structure variations of metals with heat treatment, mechanical working and electrical deposition are now determined. Apparatus for X-ray investigations combining simplicity of operation with mobility and ability for long-continued operation is produced and thicknesses of metal up to 4¾ in. can be examined. One portable set is designed for veterinary work, such as the early detection of ringbone in horses. A further small set is for examination of aeroplanes for broken spars whilst the machine is in the aerodrome. At Portsmouth Dockyard a 200-kV installation is in use, and at Woolwich one of 400 kV. Fuses are inspected at the rate of 500 per hour and castings up to 23 ft. long, the detection of blow-holes and other defects preventing further unuseful work upon the castings. X-ray tubes have been operated at 300 kV, and the line focus principle is utilised. The question of X-ray scattering is discussed, and at 200 kV the scattered radiation exceeds the direct radiation as 25 to 1. This would make it appear that the use of higher voltages, for which Compton's theory suggests a still greater proportion of scattered radiation, is unlikely to be practicable. It is, however, considered that useful work will still be possible by the use of multiple grids when the production of a higher voltage tube has been solved. Illustrations of crystal analysis as applied to metallurgical problems are given. B. J. L.

1622. Dehydration of Barium Platinocyanide under the Action of X-Rays. A. Trapesnikow. *Zeits. f. Phys.* **47. 9–10.** ***pp.* 732–744, 1928.**

The dehydration of BaPt(CN)4·4H_2O *in vacuo*, and the following hydration at atmospheric pressure, has been investigated by means of a micro-balance. Within the limit of experimental error, it appeared that the first loss of water was either $1\frac{1}{2}$ or $1\frac{1}{4}$ mols. of H_2O; when the process was repeated a number of times the modified crystal hydrate contained finally $3\frac{3}{4}$, $3\frac{1}{2}$, or $3\frac{1}{4}$ mols. of H_2O; these end products could give up 1 or $\frac{3}{4}$ mols. of H_2O *in vacuo*. The colour changes of the salt are described both with and without X-rays. The change in weight by the action of X-rays was small. H. N. A.

1623. Absorption of X-Rays. M. Ishino and S. Kawata. *Kyoto Coll. Sci., Mem.* **10.** ***pp.* 311–316,** ***Dec.*, 1927.**

The paper describes a preliminary study of the variation of absorption of X-rays with the wave-length and atomic number of the absorber, as well as a study of the influence of the physical chemical state of the absorbers on the value of the absorption coefficient. The generally accepted formula for the mass absorption coefficient is

$$\frac{\mu}{\rho} = c\lambda^p \frac{Z^q}{A} + \frac{\sigma}{\rho},$$

in which p and q are roughly 3 and 4 respectively. The measurement of the constant q is undertaken in the present investigation, using the Kα line of molybdenum over a range of elements Na to Pb. From Na to Sr q is found to be 3·88; from Ag to Pb $q = 3\cdot77$. Wingårdh [see Abstract 1875 (1922)] gives the value 3·77 to 3·61 for q, using the MoKα line. A. B. W.

1624. Dispersion and Absorption of X-Rays. J. A. Prins. *Zeits. f. Phys.* **47. 7–8.** ***pp.* 479–498, 1928.**

Assuming a distribution of resonators according to a λ^3 rule, the dispersion and absorption of X-rays is first considered theoretically. The so-called "total reflection" of X-rays is discussed, and it is shown by the use of a Fresnel formula that absorption must have a marked effect on the phenomena of reflection. In particular, the absorption limit of the reflecting element must play an important part in relation to reflection as a function of wave-length. Experimental investigations using a continuous spectrum are then described, and the behaviour of the total reflection in a steel mirror is studied in the neighbourhood of the iron limit. The results show an important modification in both absorption and dispersion near the K limit, in agreement with the theory, but to obtain a complete quantitative identity it appears to be necessary to assume the number of dispersing electrons in the K shell to be 1·3 instead of 2. W. V. M.

1625. Scattering of X-Rays from Gases. C. S. Barrett. *Nat. Acad. Sci., Proc.* 14. *pp.* 20–23, *Jan.*, 1928.

In an ideal gas the effect of neighbouring molecules on the scattering is negligible under ordinary conditions, and it may be hoped to find an effect due to the distribution of the electrons in the molecules. The author describes the apparatus employed by him in studying the scattering in hydrogen and oxygen. Monochromatic radiation was obtained by the filter method of P. A. Ross; the energy was several hundred times greater than that obtained by the crystal method. The curve showing the relation between intensity of scattered radiation and scattering angle does not agree with that deduced from the old form of Bohr's theory, with the two electrons in the molecule at a constant distance of 1·1 Å. apart. This curve has a wavy form, which is absent in the experimental one. A curve which agrees approximately with the formulæ of Compton, Breit, Dirac (Heisenberg-Born mechanics) and Gordon (Schrödinger theory) comes fairly close to the experimental points over a large range; the deviations may be due to errors in determining the volume of gas scattering the X-rays or to the unmodified radiation becoming appreciable at small angles, causing excess scattering. With oxygen, excess scattering for θ less than 60° was very prominent; CO_2 gave almost the same curve as O_2. Interference seems to be present in the case of these two gases, but not in that of hydrogen. H. N. A.

1626. Excitation of Fluorescence by X-Rays of Various Wave-Lengths. R. Glocker, E. Kaupp and H. Widmann. *Ann. d. Physik*, 85. 3. *pp.* 313–332, *Feb.* 4, 1928.

The relation between fluorescence intensity and ionisation effects in the region 0·12 to 1·54 Å. was first determined for zinc silicate layers of two different thicknesses. Then from the known relation between the absolute energy of X-rays and ionisation [see Abstract 1357 (1926)] the relation between light intensity and X-ray exciting energy could be deduced. From a theoretical estimation of the fraction of the exciting X-ray energy transformed into electron energy it is shown that for very thin sheets, if the zinc radiation is excited, the fluorescence is determined by the energy transformed into electron energy, and not by the total absorption. A way of determining the loss of light by absorption and scattering in the sample is given. J. E.

1627. Phosphorescence of Calcium Tungstate Induced by X-Rays. F. E. Swindells. *J.O.S.A. and R.S.I.* 16. *pp.* 165–173, *March*, 1928.

The rate of decay of a very phosphorescent sample of calcium tungstate was determined photographically and found to fit the empirical equation of Becquerel, $I^{-x} = a + bt$, within the experimental error, from thirty seconds to five minutes after the exposure to X-rays. The phosphorescence of this sample could not be detected photographically more than 50 hours after the exposure of 300 milliampere-seconds at a distance of 30 cm. from the target. Under the same conditions the phosphorescence of normal calcium tungstate disappeared in one minute. The intensity of the phosphorescence was found to be closely proportional to the product of the intensity of the X-rays and the time of exposure up to a limiting value, beyond which increased exposure caused a negligible increase in the phosphorescence. In general, these properties are quite similar to those of the "phosphors" of Lenard and others. AUTHOR.

1628. Fundamental Law of the Physical Action of X-Rays of Various Wave-Lengths. R. Glocker. *Zeits. f. Phys.* 46. 9–10. *p.* 764, 1928.

A correction of a previous paper [see Abstract 2934 (1927)]. The equation $\gamma = 1 - e^{-(a\bar{\mu} + \sigma_\gamma)D}$ should be replaced by

$$\gamma = \frac{(1 - e^{-\mu D})(a\bar{\mu} + \sigma_\gamma)}{\mu}.$$

For small values of μD the equations are equivalent. Previous results require only slight modification, the agreement between observed and calculated values for selenium being less exact than previously. M. V. M.

1629. Quality and Quantity of Scattered X-Radiation from Water. F. Vierheller. *Phys. Zeits.* 29. *p.* 240, *April* 15, 1928.

Corrections to original paper [see Abstract 654 (1928)].

1630. Extreme Ultra-Violet Spectra Excited by Electron Impacts. K. T. Compton and J. C. Boyce. *Frank. Inst., J.* 205. *pp.* 497–513, *April*, 1928.

The spectrum of very short wave-length radiation is photographed by optical methods, exciting the rays by the bombardment of gaseous molecules by controlled electron impacts, the voltage being of the order of 100 volts. The instrument used was a newly designed L-shaped vacuum grating spectrograph; vacuum "guard-rings" are used to prevent leakage, and these were placed round airtight waxed joints, waxed on the outside only, to avoid contamination inside the spectrograph. The pressure of the gas in the spectrograph was about 4×10^{-5} mm. The source was the usual arrangement of Wehnelt kathode and field-free-space box as anode. The source was operated at such a low pressure that no cumulative ionisation was possible, and so the different stages—arc, first spark, etc.—were controlled by the applied voltage, so obviating the necessity of discrimination in the spectrograms. Helium, neon and argon were investigated and many new terms discovered. Practically no impurity lines whatever were present in the plates. A. C. M.

RADIOACTIVITY.

1631. Radioactive Radiation. K. W. F. Kohlrausch. *Phys. Zeits.* 29. *pp.* 153–168, *March* 15, 1928.

The paper is divided into two main sections, the first dealing with the loss of energy in the passage through matter and the second with the ionising brought about by α- and β-particles. In the first section some of the points considered are as follows: the Bohr theory of the loss of velocity, the loss of velocity of α-rays, the loss of velocity of β-particles. The second section deals with the Thomson-Bohr theory and the ionising by α-particles and by β-particles. A. E. G.

1632. Excitation of Light in Gases by α-Rays. H. Greinacher. *Zeits. f. Phys.* 47. 5–6. *pp.* 344–356, 1928.

The author has endeavoured to find out whether the light produced in gases by α-rays is due wholly or in part to recombination of ions. Photographs taken with air, H_2 and O_2, in an apparatus from which the ions were removed by an electrostatic field as soon as they were formed showed that the light was not due to such recombination. The phenomenon must be due to excitation of the molecules or, in the case of hydrogen, to what the author describes as the " reaction light " of the H_2 ions. The author obtains values for the relative intensity of the light from the different gases, which differ from those obtained in previous experiments. Hydrogen gives more light than other observers have obtained. The discrepancy is due to the fact that in their apparatus the light had to pass through a quartz plate before it reached the photographic plate, while in the author's apparatus this was not the case. Much of the light from hydrogen lies so far in the ultra-violet that it is absorbed by quartz. The paper concludes with some theoretical considerations with regard to the action of α-rays on gas molecules. H. N. A.

1633. Redetermination of the Velocities of α-Particles from Radium C, Thorium C and C′. G. H. Briggs. *Roy. Soc., Proc.* 118. *pp.* 549–557, *April* 2, 1928.

Results are given of a redetermination by the magnetic deflection method of $H\rho$ or $\frac{MV}{E}$ for α-particles from radium C. The value of $H\rho$ is found to be $3 \cdot 993 \times 10^5$ e.m.u. and from the value of $\frac{E}{M}$ deduced from electrochemical data, taking into account the relative increase of mass of the α-particle, the velocity is found to be $1 \cdot 923 \times 10^9$ cm. per sec. The probable error is less than 1 in 1000. The values obtained by Rutherford and Robinson were $3 \cdot 983 \times 10^5$ and $1 \cdot 922 \times 10^9$. The velocities of α-particles from thorium C and thorium C′ were compared with that of radium C and found to be $1 \cdot 705 \times 10^9$ and $2 \cdot 053 \times 10^9$ cm. per sec. A table is included giving the velocities of α-particles from other radioactive substances deduced from Geiger's measurements of the ranges and the author's work [see Abstracts 2090 and 2091 (1927)] on the decrease in velocity of α-particles from radium C. AUTHOR.

1634. Radioactivity of the Isotopes of Potassium. M. Biltz and H. Ziegert. *Phys. Zeits.* 29. *pp.* 197–200, *April* 1, 1928.

The Hoffmann vacuum electrometer has been used to compare the activity of two specimens of potassium chloride, one of which had been prepared by Hevesy and Lögstrup by a special process of distillation from ordinary potassium, in such a way that the proportion of the heavier of the two isotopes, K_{41}, was increased by $4 \cdot 8 \pm 1$ %; the other specimen was ordinary pure KCl. The first specimen was found to have $4 \cdot 2 \pm 0 \cdot 8$ % stronger activity than the second, or within the limits of experimental error the same percentage as that for the increase of K_{41} in the first specimen, so that it appears that K_{41} is the radioactive isotope. H. N. A.

HEAT.

1635. Problems in the Conduction of Heat. G. Green. *Phil. Mag.* 5. *pp.* 719-720, *April*, 1928.

This is a continuation of a former paper [see Abstract 2093 (1927)], where it was shown that for the solution of two-dimensional problems in heat conduction there are two fundamental wave-trains travelling in the positive direction and two corresponding wave-trains in the negative direction, and that the solution of any problem can be expressed in terms of these wave-trains. The former paper dealt with plane and spherical waves, while the present paper extends the investigation to cylindrical waves. Fundamental solutions are obtained, forming the basis for the solution of problems for which the initial conditions include either a given heat distribution through space or a given temperature condition at particular surfaces. The method is then employed to determine solutions in more general problems. T. B.

1636. Volume Changes Attendant on Mixing Pairs of Liquids. J. B. Peel, W. M. Madgin and H. V. A. Briscoe. *J. Phys. Chem.* 32. *pp.* 285–292, *Feb.*, 1928.

The volume changes for each of twenty-eight liquid pairs were found by determining the densities of the pure liquids and several different mixtures with Spengel pyknometers. The results for each pair were plotted, and the curves are given in the original paper; some of them show fairly regular changes of volume, increases or decreases, while others increase at first when one constituent is added to the other and then decrease for further addition, so that the curve is wavy. There is no tendency to constancy of ratio between volume change and thermal effect, and in many cases the two are in opposite directions, with contraction in volume when heat is produced and expansion with cooling. It appears that practically the whole of the observed thermal effect is due to internal work, and may be connected with the large internal pressures which are sometimes assumed in the interior of liquids. The observed effects are not properties of liquids in general, but specific properties of chemical reagents, and chemical changes may take place when they are mixed. H. N. A.

1637. Expansion Measurements at Low Temperatures. H. Ebert. *Zeits. f. Phys.* 47. 9–10. *pp.* 712–722, 1928. *From the Reichsanstalt.*

The coefficients of expansions of the metals Pb, Mg, Al, Ag, Au, Fe and a number of glasses and porcelains and also mica were measured in the temperature range − 253° C. to 0° C., using a form of the Henning apparatus with a special envelope tube. The observed expansions for the metals are found to be in good agreement with values calculated on the basis of Grüneisen's theory of the solid state for monatomic elements.

W. S. S.

1638. Description of the Exhibits at the Eighteenth Annual Exhibition of the Physical and Optical Societies. Temperature Measuring Appliances. E. Griffiths. *Journ. Sci. Instruments*, 5. *pp.* 63–64, *Feb.*, 1928.

Short descriptions are given of: (1) A recording potentiometer combining the mechanism used in the thread recorder and the recording mechanism of the Callendar recorder; (2) types of surface pyrometers having thermocouples pointed from thin strips of the elements or a prong type having a point and spring contact with the elements separate; and (3) a total radiation pyrometer fitted with a removable and cleanable window to protect the sensitive couple from damage by dust or fumes.

R. S. R.

1639. Simple Air Thermostat. L. G. Carpenter and L. G. Stoodley. *Journ. Sci. Instruments*, 5. *pp*. 100–103, *March*, 1928.

A simple form of thermostat was devised by means of which the temperature of an air-bath could be controlled to within 0·02° C. A formula for calculating its sentiveness was developed, and the sensitivity of the temperature control was determined and was shown to be less than 0·02° C.

F. J. B.

1640. Furnaces of Tungsten and Zirconium Oxide. W. M. Cohn. *Zeits. f. tech. Phys*. 9. 3. *pp*. 110–115, 1928.

Describes tube furnaces made from tungsten wire wrapped on formers of zirconium oxide. The mode of construction is discussed in detail and drawings of typical furnaces given. They can be used up to about 2000° C.

A. A. D.

1641. Exact Determination of the Specific Heat of Solid Substances between 0° and 1625° C. Part I. Method and Apparatus. F. M. Jaeger and E. Rosenbohm. *K. Akad. Amsterdam, Proc*. 30. 8. *pp*. 905–920, 1927.

A detailed description is given of the construction of an improved "metal calorimeter" of the type proposed by Nernst, Koref and Lindemann and used by Magnus [see Abstract 159 (1927)] for measurements of specific heats up to 900° C. The calorimeter proper is a hollow cylindrical block of aluminium, weighing about 6000 grammes, contained in a large Dewar vessel. The latter fits into a zinc vessel surrounded by a volume of 260 litres of water contained in an outer vessel of thick wood padded with clay wool. The temperature of the aluminium block is measured by 36 thermo-elements of copper-constantan. The object of experiment is heated in an electric furnace from which no radiation to the calorimeter is possible even at a temperature of 1625° C. The method of determining the water equivalent of the calorimeter is given. Results are obtained which agree within 0·063 %.

T. B.

1642. Exact Determination of the Specific Heat of Solid Substances between 0° C. and 1625° C. Part II. The Specific Heat of Platinum and Tungsten. F. M. Jaeger and E. Rosenbohm. *K. Akad. Amsterdam, Proc*. 30. 9–10. *pp*. 1069–1088, 1927.

Making use of the method and apparatus described [see preceding Abstract], the authors have determined the specific heats of platinum and tungsten at constant pressure from 0° to 1625° C. For platinum the results are as given by the formula $C_p = 0\cdot03162 + 6\cdot1725 \times 10^{-6}t + 2\cdot3325 \times 10^{-10}t^2$. This is in good agreement with the values obtained by White [see Abstract 314 (1919)]. It is observed that there is no retardation in the increase of the atomic heat at constant pressure. A considerable deviation is, therefore, found from the theoretical value when the specific heat C_v at constant volume is calculated from the thermodynamical equation $C_p - C_v = (0 \cdot 02345 \,.\, (3a)^2 \,.\, T)/x \,.\, d$. In determining the specific heat of pure tungsten correction had to be made for the formation of various oxides at high temperatures. The corrected values are expressed as $Cp = 0 \cdot 0274412 + 0 \cdot 132672 \,.\, 10^{-4}t - 0 \cdot 091488 \,.\, 10^{-8}t^2 + 0 \cdot 067812 \,.\, 10^{-11}t^3$. These results differ rather widely from the previous values obtained, chiefly by indirect methods such as those on evacuated electric incandescent lamps. T. B.

1643. Measurement of the Variation of the Specific Heat of Aniline with Temperature Using the Continuous-Flow Electric Method. H. R. Lang. *Roy. Soc., Proc.* 118. *pp.* 138–156, *March* 1, 1928.

The continuous-flow method has been used for the measurement of the specific heat of aniline over short ranges of temperature between 5° and 75° C. Over this range the rate of change of specific heat with temperature increases with rise of temperature. Results were also obtained with aniline below 5° C., but are uncertain owing to the high viscosity of aniline at these temperatures. Precautions were taken to use only pure dry aniline and the small water content ascertained in each case. The principle of the method was to allow the liquid aniline to flow through a narrow-bore tube through which passes a manganin strip, which is electrically heated. The resulting rise in temperature is then measured. Full experimental details are given as well as tables of results and a note on the influence of the presence of moisture on the specific heat values. S. G. B.

1644. Mean Specific Heats of Diatomic Gases (N_2, CO, O_2, H_2) of Carbon Dioxide and of Water Vapour in the Temperature Region between 0° C. and 3000° C. Absolute. F. Schmidt and H. Schnell. *Zeits. f. tech. Phys.* 9. 3. *pp.* 81–92, 1928.

The specific heats of the above-mentioned gases determined previously have been recalculated and otherwise obtained from the results of experiment and other information gained from the literature of the subject. The collected results of different workers are surveyed and curves derived as the result of the present treatment of their work and observations. Primarily, the present values have been obtained for use in thermodynamical calculations for the theory of combustion engines, but in addition the quantity $C_v^m\Big/_0^T$ has been deduced. S. G. B.

1645. Thermal Data for Tin and Supposed Retardation Phenomena in the Allotropic Transformation of Tin. J. N. Brönsted. *Zeits. f. phys. Chem.* 131. *pp.* 366–370, *Feb.*, 1928.

A reply is made to the criticism made by Cohen and Moesveld (*Zeits. f. phys. Chem.* 115. p. 151, 1925) that the results of the author's determinations of the thermal data for tin [Abstract 92 (1913)] are worthless owing to lack of attention to the physical purity of the material employed. The results recently published by Cohen and Dekker (*Zeits. f. phys. Chem.* 127. p. 183, 1927) for the specific heats of white and grey tin are practically identical with the author's values. T. H. P.

1646. A Calorimeter for the Determination of the Heat Developed by Fruit. E. Griffiths. *Phys. Soc., Proc.* 40. *pp.* 46–53; *Disc.*, 53, *Feb.*, 1928.

A calorimeter for measuring the heat evolved by apples during the senescence stage is described. A differential arrangement is used, one container being filled with apples and the other with dummy apples of the same thermal capacity, made of thin-walled glass spheres filled with moistened glass wool. These containers are enclosed in a metal box thermally insulated, and set up in a constant temperature room. Resistance thermometers composed of 80 yards of nickel wire in glass tubes are disposed among the apples and the dummies. They are connected differentially to a slide wire, on which a difference of one-thousandth of a degree causes a movement of the contact-maker of 3 millimetres. The air circulation is controlled so as to maintain at will atmospheres containing from 2 to 10 % of CO_2 around the apples. The moisture content of the air before and after circulation is determined by a dew-point apparatus, and a correction applied for the heat absorbed in evaporating water from the apples. The results show that at a temperature of 20° C. sound apples generate heat at the rate of about 0·012 calorie per second per kilogramme of apples. Or for an apple of average size (2¼ in. in diameter) the rate of heat generation per second is one and a half thousandth calorie. AUTHOR.

1647. Apparatus for the Determination of the Raising of the Boiling Point. F. Rusch. *Ann. d. Physik,* **85. 5.** *pp.* **647–648,** *March* **19, 1928.**

A brief note on an apparatus which replaces the Swientoslawsky system of measurement of the rise of the boiling point. The new method is cheap and easy to manipulate. A full description is given, together with photos and diagrams of the actual apparatus. S. G. B.

1648. Melting-Point Line of Helium and Nernst's Theorem of Heat. W. H. Keesom. *K. Akad. Amsterdam, Proc.* **30. 9–10.** *pp.* **952–956, 1927.** *Comm. No.* **61***b from the Phys. Lab., Leiden.*

This paper is a detailed explanation in reply to a criticism by van Laar [see Abstract 2571 (1927)] of a previous paper on the solidification of helium [see Abstract 1061 (1927)]. The question answered is: "What do the measurements concerning the melting curve of helium teach about the heat theorem of Nernst?" And the author points out that without extrapolation nothing can be said about the theorem of Nernst. Based on this assumption, the author argues in favour of his previous viewpoint concerning the course of the melting curve of helium at lower temperatures, *viz.*, Lim. $dp/dt = 0$. H. H. Ho.

1649. Melting-Point Line of Helium and Nernst's Theorem of Heat. J. J. van Laar. *K. Akad. Amsterdam, Proc.* **30. 9–10.** *p.* **957, 1927.**

The author, in reply to Keesom's considerations [see preceding Abstract], maintains his previous attitude and awaits decisive experiments to give certainty about the course of the melting-point line within the debatable range. H. H. Ho.

1650. Properties of Dry Liquids. S. B. Mali. *Phil. Mag.* **5.** *pp.* **609–614,** *March,* **1928.**

Baker has shown that the boiling points of many liquids are changed when the liquids are desiccated. Smits explains this by supposing that in ordinary liquids there are at least two modifications with different properties between which reversible reactions of the type $\alpha \rightleftharpoons \beta$ are taking place. By the process of drying, the velocity of one or both of these reactions is reduced. The present author assumes that the dried liquid is a solution of the less volatile liquid α in a mixture of the two components as they exist in the moist liquid. Assuming the thermodynamical relation between the rise of boiling point and the amount of solute present, an attempt is made to calculate the relative amounts of the two components in moist and dry liquids. The results indicate that in the case of benzene, CS_2, CCl_4 and bromine the amount of the less volatile component in the dried liquid is comparatively very large. It is also deduced that in the case of the alcohols and ether the molecules in the dried liquid are dissociated. A theory of residual affinity is offered to account for the phenomena, and it is concluded that there should be little or no difference between a moist and a dry liquid at very low temperatures. T. B.

1651. Chemical Constant of Hydrogen Vapour and the Failure of Nernst's Heat Theorem. R. H. Fowler. *Roy. Soc., Proc.* 118. *pp.* 52–60, *March* 1, 1928.

According to Dennison, hydrogen at low and ordinary temperatures must be regarded as a mixture of two effectively distinct sets of molecules, antisymmetrical and symmetrical; the ratio between the numbers of these two kinds of molecules may be taken as 3 : 1. The author finds that the vapour-pressure equation of hydrogen can be satisfactorily accounted for if both antisymmetrical and symmetrical molecules are present indifferently in the vapour and condensed phases. The "weight" of the hydrogen molecule in the crystal form is not unity, but must be 9 and 1 for the lowest states of the two kinds of molecules. The constant in the equation is not the chemical constant of gaseous hydrogen, but smaller by $\frac{3}{4}$ log 3. Eucken has already suggested an alteration in the constant of about this amount. The author concludes that both theory and observation suggest that Nernst's heat theorem should not hold for reactions in which hydrogen takes part. The above depends on the fact that hydrogen must be treated as a metastable mixture; it may be better to say that Nernst's heat theorem is inapplicable to ordinary reactions in the case of hydrogen, though it might be, and probably is, true if they are carried out exceedingly slowly, so that the gas can arrive at its true equilibrium state. H. N. A.

1652. Kinetic Theory. F. Persico. *Accad. Lincei, Atti*, 7. *pp.* 137–141, *Jan.* 15, 1928.

Maxwell and Boltzmann's laws for perfect gases break down at very low temperatures or very great densities; or, in general, when the ratio $a = nh^3/(2\pi mk\mathrm{T})^{3/2}$ is not negligible as compared with unity. In such cases the movement of the molecules is subject to quantic laws, and Pauli's electron hypothesis has to be applied to molecules, that there cannot exist in a gas two equal molecules with the same quantic numbers. In particular there cannot at any instant exist two equal molecules having the same components of velocity. A gas in this condition is called a degenerate gas, and would have even at absolute zero a certain energy and a certain pressure. This condition may be realised when T is small, when n is great, and when m is small (electrons). The distribution of the velocities has been calculated by Fermi [see Abstract 1867 (1926)] on a simplifying hypothesis. The present paper investigates quantitatively how the law of distribution of velocity, that of repartition in the various states of excitation, and that of the probability of transition (Einstein) have to be modified in a monatomic degenerate gas through the interdependence set up by Pauli's principle. A. D.

1653. Kinetic Theory of a Gas in the Neighbourhood of a Wall. M. Brillouin. *Comptes Rendus*, 186. *pp.* 553–558, *Feb.* 27, 1928.

The radius of curvature of the wall is supposed great compared with the mean distances and mean free path of the gas molecules. A double rôle is attributed to the wall as proposed by Maxwell in 1868: (1) The wall can reflect each incident molecule according to a rigorously defined law; the probability of speed after reflection is then defined by the incident velocity and the molecular circumstances of the impact. (2) The incident gaseous molecule may be absorbed (as in solution) in the wall itself, perhaps later to be re-emitted without any relation to the speed or direction of the incident molecule. In the immediate neighbourhood of the wall the distribution of speeds depends too much on the wall for one to be able to define it by one continuous function. The discontinuity persists, but gets less and less away from the wall, but eventually ends in the law of distribution of Maxwell. Two sorts of molecules are considered: (1) Molecules which come from the gaseous mass without having touched the walls; (2) molecules which emanate directly from the wall. Six equations are evolved, from which the author deduces the distributions and densities in the layer of gas near the wall. T. B.

1654. Relativistic Quantum Theory of the Ideal Gas. F. Jüttner. *Zeits. f. Phys.* 47. 7–8. *pp.* 542–566, 1928.

The author worked out the theory of the ideal monatomic gas by means of the special relativity theory in 1911, using the Boltzmann-Planck statistical method but without consideration of the quantum theory. In the present paper relativistic mechanics, and also the quantum theory, are employed, the statistical methods of Bose and Einstein and of Fermi and Dirac, which are complementary to one another in wave mechanics, being made use of. Unlike the older theories, the Maxwell distribution of velocities does not hold in the new theory, and single Bessel functions no longer occur, but infinite series of these. The method of treatment of a moving gas is also indicated, its kinetic potential being given. The importance of the two generalised theories obtained, based one on the Bose-Einstein and the other on the Fermi-Dirac theory, is essentially theoretical; it is only at enormously high temperatures that the velocity of the gas molecules is comparable with the velocity of light, when the differences between the relativistic and the Newtonian mechanics will become perceptible. On the other hand, the quantisation of the motions of translation only produce a marked effect at low temperatures, so that the full theories could only be tested at ordinary temperatures by means of extraordinarily accurate measurements. H. N. A.

1655. Mutual Attraction and Repulsion of Gas Molecules and the Theory of Internal Friction. L. Schames. *Phys. Zeits.* 29. *pp.* 91–94, *Feb.* 1, 1928.

The internal energy of two molecules at distance r can be written as

$$\phi = -\frac{A}{r^m} + \frac{B}{r^n},$$

where the first term is due to attraction and the second to repulsion. At temperature $T = O$, $r = r_0 = S_0$ (the diameter of a molecule) and ϕ is a minimum. At a higher temperature r becomes less than r_0, and we have $\phi_s = \phi_0 = kT$, where k is Boltzmann's constant. Putting $\rho = \frac{r}{r_0}$ and $\sigma = \frac{S}{r_0} = \frac{S}{S_0}$ and $\frac{A}{r_9^m} = kT_0$, we find

$$\phi = kT_0\left(-\frac{1}{\rho^m} + \frac{m^0}{n}\cdot\frac{1}{\rho^n}\right),$$

and $\phi = -kT_0\frac{n-m}{n}$, and substituting these in the previous equation, we obtain

$$\frac{n-m}{n} - \frac{1}{\sigma^m} + \frac{m}{n}\frac{1}{\sigma^n} = \frac{T}{T_0},$$

which shows how σ depends on the temperature, under the supposition that there exists both an attractive and a repulsive force between the molecules. The expression for the internal friction of a gas has been given by Jeans as

$$\eta = \frac{1}{\pi S^2 N}\sqrt{\frac{RTM}{\pi}}.$$

From observed values of n at different temperatures, S for helium has been calculated and compared with the values of S, calculated by substituting in Jean's expression the values obtained from the previous equation, connecting σ with temperature. A close agreement is found, and the values $m = 8$ and $n = 9$ were found to be the only suitable ones. The author states that the deductions of Lenard-Jones, who gives to n the value 13, are not correct, since he leaves out the attractive forces. On the other hand, the results obtained by Zwicky confirm those of the author, whose results also confirm Debye's theory that for the inert gases the attraction is due to polarisation. T. B.

1656. Approximate Theories of Diffusion Phenomena. S. Chapman. *Phil. Mag.* 5. *pp.* 630–636, *March*, 1928.

If there be two kinds of molecules of masses m_1, m_2, the numbers of which per unit volume are n_1, n_2, and mean speeds C_1, C_2, and $n = n_1 + n_2$, $c_1 = \frac{n_1}{n}$ and $c_2 = \frac{n_2}{n}$, so that $c_1 + c_2 = 1$, then $m_1C_1^2 = m_2C_2^2 = aT$, where T is the absolute temperature and a is a universal constant. If there is a temperature gradient along the direction of z, the pressure being uniform, the argument which is the basis of Meyer's theory of diffusion [*Kinetic Theory of Gases* (English translation), p. 255] states that the number of molecules which cross any plane of constant z per unit area per unit time in the positive direction is $k(n_1C_1)_{z-\lambda}$, where k is a numerical constant and the suffix implies that the value of n_1C_1 is that at a plane $z - \lambda_1$ distant λ_1 on the negative side of the plane z; λ_1 is a multiple of the mean free path of the molecules by a factor which, like k, is independent of the nature of the gas and of the variables of state. Similarly, the rate of flow in the opposite direction is $k(n_1C_1)_{z+\lambda_1}$. The gas being in a state of equilibrium, and there being no resultant diffusion, these two quantities must be equal, so that n_1C_1

is independent of z. Hence, $n_1T^{\frac{1}{2}}$ is constant along the tube. This leads to the result that there is no gradient of concentration, which is contrary to the facts. This argument, which is generally reproduced in modern textbooks on the theory of gases and has recently been used in an attempt to explain the Soret phenomenon in liquids, is found to lead to results which are qualitatively correct in certain respects, but it predicts phenomena that either do not occur, or are inconsistent with the initial hypotheses, or are deduced with the wrong sign. Examples of each of these cases are given. T. H. P.

1657. Loss of Heat of a Hot Body in a Moving Fluid. J. Schmekel. *Zeits. f. tech. Phys.* 9. 2. *pp.* 49–57, 1928.

A formula is derived from the heat conductivity equation for moving media for the influence of free cooling and its convection currents on the actual cooling for the limiting cases of large and small velocities. These were proved experimentally by the work of Nusselt and Jurges, Nusselt and Hughes, and found correct. From Nusselt's measurements a means was found for the explanation of a discrepancy at small velocities in the influence of laminated currents on the turbulence. The difference between the heat exchange or loss by the heat current-liquid and conversely was explained by the direction of the convection stream. The discussion of oscillations was conducted on a physical basis. The apparent discrepancy between experiment and theory was attributed to hydrodynamical causes. S. G. B.

1658. Internal Energy and Entropy. R. D. Kleeman. *Phil. Mag.* 5. *p.* 668, *March*, 1928.

Referring to a paper [see Abstract 2101 (1927)], in which he showed that the controllable internal energy and entropy of a substance under its vapour pressure at the absolute zero of temperature are zero, the author points out that the theorem he established and used to prove this —*viz.*, that the specific heat at constant volume is a positive quantity—may be shown to follow simply from our notions of heat, thus: Suppose that a substance A is completely surrounded by a substance B at the same temperature, and that the former substance has a negative specific heat. Let B be raised in temperature by δT. An initial flow of heat from B to A will occur. Heat will now be evolved in A tending to produce a flow of heat in the opposite direction, since its specific heat is negative. Let this flow of heat be checked by keeping the substance B at the same temperature as that of A till no further change in its temperature takes place. Thus the temperature of A may be raised to any desired value by repeating the process often enough. Evidently A will only receive heat under these conditions; in other words, a negative specific heat is impossible. The result holds whether A is kept at constant volume or at constant pressure. J. J. S.

1659. Derivation of the Maxwell Distribution Law from Thermodynamics. A. Schükarew. *Phys. Zeits.* 29. *pp.* 181–182, *March* 15, 1928.

Maxwell's law of the distribution of kinetic energy or of the velocities of gas molecules was derived from probability considerations, and since the law has received experimental confirmation, it must possess a physical basis. The present author now derives the law from simple thermodynamic considerations. H. H. Ho.

SOUND.

1660. Problem in Under-Water Acoustics. J. H. Powell. *Frank. Inst., J.* 203. *pp.* 791–793, *Dec.*, 1927.

The paper constitutes a reply to one of the same title by A. S. Eve [see Abstract 1090 (1927)] relating to the production of a unidirectional hydrophone for use in the detection of submarines. Attention is now drawn to a paper by Wood and Young [see Abstract 962 (1922)], who proposed a theory of the action of the directional hydrophone and " baffle " which was in approximate agreement with observations. The author now suggests some modification of this theory to account for certain observations with " baffles " made up of xylonite and lead shot.

A. B. W.

1661. Vibration of String with Sine Distribution of Mass. M. J. O. Strutt. *Ann. d. Physik*, 85. 2. *pp.* 129–136, *Jan.* 25, 1928.

Some facts discovered by Lord Rayleigh with regard to the vibration of strings with a periodically variable mass distribution are treated mathematically by means of Mathieu's differential equation. The theory conforms with the results, and it is found possible to determine experimentally the limits between stable and unstable solutions of the Mathieu equation by means of the proper vibration of the strings in question.

E. E. F. d'A.

1662. Struck String. K. C. Kar, R. Ganguli and S. C. Laha. *Phil. Mag.* 5. *pp.* 547–559, *March*, 1928.

Experiments on the struck string in which an unyielding hammer is used. Attempts are made to measure the amplitude of some of the partial tones by observing with a microscope the amplitude of the string's motion at a suitable antinode after some of the particles have been removed by damping the string at some other suitable point. The results are given in some cases to 1 part in 28,000. It is claimed that the observations agree with the work of Kaufmann and George and Beckett, but that Das's extension of Kaufmann's theory disagrees with experimental evidence and that calculations made by Datta to confirm Das's theory are wrong.

W. H. Ge.

1663. Acoustic Oscillograph ; Human Voice ; String Instruments. W. S. Kasansky and S. N. Rschevkin. *Zeits. f. Phys.* 47. 3–4. *pp.* 233–273, 1928.

An acoustic oscillograph containing a heavily damped cork membrane is described, together with its calibration over a frequency range of 200–2000 per sec. It is then applied to the study of the tone quality of many types and examples of human singing and speaking voices and to bowed violins, old (Strad, Amati, Maggini, etc.) and new, and to the 'cello. Sixty-eight of the photographically recorded curves are reproduced, together with elaborate analyses of their tone spectra, which are shown graphically. The authors' summary of the results (p. 233) should be consulted. Throughout this elaborate paper the results are clearly set out.

W. H. Ge.

1664. Constrictions in Kundt's Apparatus and End Corrections of a Partially Stopped Tube. E. J. Irons. *Phil. Mag.* 5. *pp.* 580–592, *March*, 1928.

Deals with experiments made to determine the effect on the distribution of nodes and antinodes of introducing a diaphragm constriction into a Kundt tube. End corrections of a partially stopped tube were studied by fitting on the end of the tube caps having openings of different apertures. Cork-dust was used to indicate the position of the antinodes so as to make unnecessary special precautions as to dryness. The results are given graphically and cannot easily be summarised. W. H. Ge.

1665. Coefficient of Sound Absorption Measured by the Reverberation Method. E. T. Paris. *Phil. Mag.* 5. *pp.* 489–497, *March*, 1928.

A formula is obtained which relates the reverberation coefficient of absorption to the coefficient for plane waves incident at a given angle. The former coefficient can be calculated only if the latter is known for all angles. But, in the case of porous tiles such as akoustolith, the reverberation coefficient can be found from the acoustical admittance per unit area [see Abstract 2741 (1927)]. In a special case the admittance can be expressed in a simple form, and the numerical values for an ideal porous substance show that, in general, the reverberation coefficient differs from the coefficient for normal incidence. [See Abstract 3162 (1927).] G. E. A.

1666. Modification of Rayleigh Disc Method for Measuring Sound Intensities. L. J. Sivian. *Phil. Mag.* 5. *pp.* 615–620, *March*, 1928.

The new method is applicable when the sound amplitude can be made a suitable function of time. The amplitude of the sound wave to be measured is modulated with a frequency equal to that of the free vibration of the suspended disc, and the measurement consists in reading the amplitude of oscillations corresponding to the modulating frequency rather than a steady deflection of the disc. Disturbances caused by spurious air currents are largely reduced, and for many practical cases a gain in absolute sensitivity is claimed. The theory is given. W. H. Ge.

1667. Effect of Horns of Short Lengths on the Intensity of Sound from a Telephone Unit. B. L. Steele. *Phys. Rev.* 31. *pp.* 482–487, *March*, 1928.

By means of a condenser microphone associated with a multistage resistance-coupled amplifier, a vacuum thermocouple, and a microammeter, the effect of very short horns on the intenstiy of the sound output of a telephone unit was determined. The response-frequency curves for twelve conical horns of varying flare and length, together with the output-frequency curve for the telephone unit itself, showed that by the use of these short horns the intensity of the sound radiated was considerably increased over a wide range of frequencies extending from the upper limit used, 4000, to frequencies much lower than that corresponding to a wave-length equal to four times the length of the horn. The flare of the horn materially affected the sound output. The heights of the peaks in the response-frequency curves, but not their distribution, were affected by the material of the horn. These horns have little value as loud speakers. Author.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS AND ATMOSPHERIC ELECTRICITY.

1668. Some Experimental Difficulties with the Electromagnetic Theory of Radiation. A. H. Compton. *Frank. Inst., J.* **205.** *pp.* 155–178, *Feb.*, 1928.

The phenomena considered are: (*a*) the emission of radiation by atoms, in particular the production of the continuous X-ray spectrum; (*b*) the photoelectric effect; (*c*) the scattering of electrons, including the Compton effect and recoil electron phenomena; and (*d*) individual interactions between radiation quanta and electrons as disclosed in experiments with Geiger's point counters and Wilson's cloud expansion apparatus. The classical wave theory is definitely inconsistent with observation. The statistical theory of Bohr, Kramers and Slater, which postulates virtual oscillators continually emitting virtual radiation, to which, however, no energy characteristics are ascribed, is, as regards (*a*), (*b*) and (*c*), quite consistent with the results of experiments on a microscopic scale, but would not, of itself, enable the observed characteristics to be predicted. A number of experiments under (*d*) seem definitely contrary to the statistical theory. Finally, the " photon " or " light quant " hypothesis provides a straightforward explanation of all the phenomena. The solutions of the scattered X-ray intensity problem obtained by Dirac and others using the new quantum mechanics apparently do not introduce any new concepts regarding the nature of radiation or of the scattering process. W. S. S.

1669. Field Lines. Jean Spielrein. *Zeits. . tech. Phys.* **9.** 2. *pp.* 75–76, 1928.

From the differential-geometric properties of vectorial fields: If the field lines coincide with the isodynams and the field vector be free from sources, the orthogonal surfaces of the field lines must be minimal surfaces. Such a meridian plane field is impossible, and a parallel-plane field must have parallel field lines. If the field vector be also free of whorls, the only possible plane field consists of concentric spheres, of which the limiting case is a parallel uniform field. A. D.

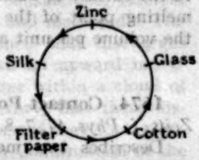
1670. Problem of a Hidden Polarised Sphere. A. Petrowsky. *Phil. Mag.* 5. *pp.* 334–353, *Feb.*, 1928.

The following is the problem considered: All infinite space is divided into two parts by a plane, and the medium filling the upper part represents a dielectric, whereas the medium filling the lower possesses conductivity. In some region of the lower part an ideally conducting sphere is hid, the centre of which is at a depth h under the plane of division and is projected on the latter in a point O_0. By any causes whatever the sphere is polarised, *i.e.*, it develops an e.m.f. of its own which has the greatest value along a certain diameter (axis of polarisation) inclined at an angle α to the vertical and diminishes by cosmic law in dependence on the angle θ which is formed by the given direction and the axis of polarisation, $\varepsilon = E \cos \theta$. At the same time, in the conducting medium surrounding the sphere a current is formed which spreads over the whole lower part of the space, evoking electric and magnetic effects. It is required to determine whether it is possible, and in what manner, by observing the above-mentioned effects on the plane of division (or near it), to find all elements characterising the hidden sphere, *i.e.*, the exact situation of O_0, the projection of the centre, the depth of its bed h, and the radius of the sphere r_0. The problem is attacked by analysis and by graphical methods. Expressions are obtained for the electric potential in any outer and in any inner point of the sphere: $U_{ex} = E_0r^2/2r^2 \,.\, \cos\theta$, $U_{\text{int.}} = Er/2r_0 \,.\, \cos\theta$, and for the electric force at points in the external and inner fields. The distribution of iso-potential lines of force is shown graphically. Particular cases and a general case are considered with the help of electroprofiles.

J. J. S.

1671. Tribo-Electricity and Friction. Parts II and III. P. E. Shaw and C. S. Jex. *Roy. Soc., Proc.* 118. *pp.* 97–113, *March* 1, 1928.

Part II. Glass and Solid Elements.—Quantitative results are aimed at, the two surfaces being pressed together with a definite force and rubbed over a definite length. After each rub, the deflection of an electroscope is noted. Curves are given showing the results. Some elements (*e.g.*, C, Cd, Fe, Pb, Bi, Ag, etc.) never show a negative charge. Others (such as Zn, Sn, Al, Sb, Ni,* Co, Cr, S) show ultimate negative charge. Evidence is given of the predominating influence on the charging of residual acid, alkali, or water film on the glass. The results appear to be the same when the rubbing is done *in vacuo* as in the open air. Reference is made to various theories on the subject, and it is urged that tribo-electricity cannot be a purely statical effect; the kinetic effects must be important and may be paramount.



Part III. Solid Elements and Textiles.—Apparatus and methods used are the same as in Parts I and II, except that the element is rubbed, not on glass, but on the textile wrapped round glass rods. The results for the solid elements rubbed with silk, cotton, and specially prepared filter-paper are shown diagrammatically beside the corresponding results for glass given in Part II. It is shown that it is impossible to devise a simple tribo-electric series of one column to include all solids. For example, the five materials, zinc, silk, filter-paper, cotton, glass, are related in a continuous ring as in the figure, the arrow in each case pointing from positive to negative.

T. B.

[For Part I, dealing with glass/textiles, see Abstract 2423 (1926).]

1672. Electrostatics in a Gravitational Field. E. T. Copson. *Roy. Soc., Proc.* 118. *pp.* 184–194, *March* 1, 1928.

Recently E. T. Whittaker has discussed the effect according to the general theory of relativity of gravitation on electromagnetic phenomena [see Abstract 695 (1928)]. Electrostatics in gravitational fields of two kinds were investigated: (i) The field due to a single gravitating mass, in which space-time has the metric discovered by Schwarzschild; and (ii) a limiting case of this, called a *quasi-uniform* field. Whittaker found an algebraic expression which represents the potential of a single electron in the quasi-uniform field. The author of the present paper proceeds to determine the potential of an electron in the Schwarzschild field in an algebraic form. This he does by another method of investigation—that of Hadamard's theory of "elementary solutions" of partial differential equations. Further, the new solution is expanded in terms of generalised harmonic functions, some of the relations obtained being new properties of the Legendre functions. One rather curious result obtained in the course of the analysis is that the potential of an electron on the boundary sphere $R = a$ is independent of its position on the sphere. J. J. S.

1673. Contact Potential between Solid and Liquid Bismuth. P. H. Dowling. *Phys. Rev.* 31. *pp.* 244–250, *Feb.*, 1928.

In order to obtain as gas-free metal as possible, bismuth is distilled into highly exhausted apparatus. The contact potential is measured by the standard Kelvin method against a copper plate whose absolute potential is maintained constant by protecting it from the temperature changes incidental to melting and solidifying the bismuth. Solid bismuth has a contact potential of the order of − 0·020 volt with respect to the molten metal. From the results on the contact potential between the two phases of bismuth, it can be shown thermodynamically, following Bridgeman's treatment of the matter, that, when one coulomb per cm.^{2} is added to the surface of bismuth at constant volume, pressure, and capacity the melting point of the metal increases by $(1/V) \times 0{\cdot}020^\circ$ C., where V is the volume per unit area of the solid bismuth at its melting point.

E. E. F. d'A.

1674. Contact Potentials between Metals *in Vacuo*. G. Mönch. *Zeits. f. Phys.* 47. 7–8. *pp.* 522–541, 1928.

Describes two methods for measuring contact potentials between metals, in which electron streams from incandescent kathodes, cylindrical "grids" with a narrow slit to allow the electron stream to pass, and concentric cylindrical anodes are made use of. In the final apparatus, using the second method, the whole system was enclosed in a glass cylinder with fused joints, and the anodes could be lowered into an electric oven in the evacuated cylinder and brought to red-heat, thus getting rid of surface impurities. This treatment was found to modify profoundly the position of the metals tested in the contact potential series, the signs of the contact potentials between different metals being in many cases reversed. The effect of introducing hydrogen into the cylinder after the anodes had been "glowed" in the oven was observed, and it was found that the contact potentials were again affected, and in many cases reversed. The measurements were made by applying different retarding voltages to the electron stream passing towards anodes of different metals, obtaining the curves showing the relation between the current and the retarding voltage, and measuring the horizontal shift between the curves for the different metals, which gave the contact potential between them. H. N. A.

1675. Parallel-Plate Condenser. Doris M. Hirst and W. B. Morton. *Phil. Mag.* 5. *pp.* 545–547, *March*, 1928.

A note extending the calculations of a previous paper [see Abstract 433 (1927)] on the "capacity-factor" and the "shape-constant" of a condenser formed by long parallel strips. The results are given in a graph.

W. H. Ge.

1676. New Experiments on the Johnson-Rahbeck Effect. G. Neidl. *Zeits. f. tech. Phys.* 9. 2. *p.* 22, 1928.

The original Johnson-Rahbeck effect, which was that when a metallic plate is placed upon the highly polished surface of a partially conducting plate one side of which has a metallic coating, and the plate and coating subjected to unlike voltages, then between the metallic and semi-conducting plates an extraordinarily strong attraction arises. The present author replaces the metallic plate by mercury and obtains rhythmic movements by periodic voltage alternations which may be optically observed. The device may be applied to the measurement of voltages with great resistances. H. H. Ho.

1677. Polarity of Thunderclouds. B. F. J. Schonland. *Roy. Soc., Proc.* 118. *pp.* 233–251, *March* 1, 1928.

The author provides additional data in support of his theory regarding the electric fields around thunderclouds. The main equipment already described [see Abstract 2119 (1927)] was extended to deal with storms 40 to 50 km. distant. Detailed explanations are given of several tests which can be applied to determine the polarity of the thundercloud, some of which afford a definite decision regarding polarity; others provide useful information bearing on it, and another is of considerable interest in other ways. The results obtained are tabulated and discussed. The author concludes that: (*a*) No evidence was obtained that discharges within a thundercloud, near or distant, ever involve an upward movement of positive charge such as must frequently occur within a cloud of negative polarity. The results indicate, on the contrary, that these discharges are invariably downwards, as would be the case if they took place between the poles of a cloud of positive polarity. (*b*) Confirmation of the view that these clouds were of positive polarity was given by the facts that the charge carried away by a flash between the base of the cloud and the earth was practically always found to be negative, the strong fields below active clouds were invariably and persistently negative, and the fields due to distant clouds practically always positive, when they could be measured. Further, outside observations of lightning flashes indicate that only a very small percentage of flashes within the clouds could produce positive charges. Thus, upward discharges of positive electricity do not occur, and consequently the negative pole of the cloud was below and not above the positive pole. R. S. R.

1678. Interchange of Electricity between Thunderclouds and the Earth. B. F. J. Schonland. *Roy. Soc., Proc.* 118. *pp.* 252–262, *March* 1, 1928.

The paper describes observations made to examine the part played by (*a*) continuous currents carried by ions moving in powerful electric fields below a thundercloud, (*b*) lightning discharges between cloud and ground, and (*c*) convection currents carried by rain, in the electrical interchange between an active thundercloud and the earth. Of these (*a*) is the most important owing to the point discharge from trees and bushes below the cloud, and for this a suitable tree was cut down and insulated on sulphur-ebonite, the current and field being measured. The current was found to be of the same order as Wormell measured [see Abstract 2964 (1927)] and possessed the same predominance of upward currents. From the several sets of observations it was estimated that (*a*) and (*b*) produce continuous currents of the order 2·1 and 0·1 equivalent amperes respectively in an upward direction, and (*c*) produces a reverse downward current of 0·02 ampere. The resultant current is thus 2·2 amperes in such a direction as to convey a negative charge to the earth. [See also Abstract 2119 (1927).] R. S. R.

DISCHARGE AND OSCILLATIONS.

1679. Spark Experiments with the Kathode Oscillograph. R. Tamm. *Arch. f. Elektrot.* 19. *pp.* 235–256, *Jan.* 25, 1928.

In the penetration of homogeneous fields two phases of the break-through can be distinguished: (*a*) Passage in the glow-discharge (several thousand volt discharge tension); (*b*) passage in the spark discharge (spark tension very small). The Toepler spark law does not hold in these conditions. The presence of spark lag is proved experimentally. "Active electrodes," without radiating, behave like ordinary electrodes with radiating. They have a minimum lag. The lag is very great in fields which are not homogeneous, *e.g.*, point against point. In the case of point against plate the lag is smaller when the point is positive. An influence of electrode materials and electrode temperature is not established. Gliding sparks have the same character as the penetrating in fields not homogeneous. [See also Abstract 188 (1927).] A. E. G.

1680. New Effect in the Electric Discharge. T. R. Merton. *Roy. Soc., Proc.* 117. *pp.* 542–549, *Feb.* 1, 1928.

There are a number of spectra which are seen under appropriate conditions of excitation in vacuum tubes containing helium with a small trace of some other gas, but which are difficult to isolate under other conditions. In particular the arc spectrum of carbon and the band spectrum known as the comet tail spectrum can be observed very favourably under these conditions. In the course of investigations of this spectrum in vacuum tubes containing helium, some very peculiar types of striated discharge were observed, and further investigation leads to the conclusion that these striæ are of a very special type and are quite different from those which are usually observed in vacuum tubes. They exhibit certain peculiarities which may perhaps justify the suggestion that this type of discharge is akin to the rare phenomenon known as ball lightning. This disc discharge, which is the subject of the present paper, can only be maintained with an alternating current discharge, and is entirely unaffected by weak magnetic fields. A large number of mixtures of gases are investigated, but in no other case excepting that of a neon tube provided with carbon electrodes is the disc discharge observed, and in this case it is only seen four times for a few seconds. The tubes are exactly similar in construction to those used in the case of helium. The comet bands appear rather feebly in neon, but not at all in argon tubes. A theoretical treatment of these phenomena cannot at present be given, but a discussion of certain main features are attempted. The explanation of the disc discharge is probably closely related to the migration of the carbon compounds. The discs observed are certainly regions where chemical decomposition is taking place. A. E. G.

1681. Spark Potentials in Nitrogen. B. Frey. *Ann. d. Physik,* 85. 4. *pp.* 381–424, *Feb.* 21, 1928.

This work was originally intended as an investigation of the influence of the magnetic field on the spark potential in nitrogen and the rare gases. In the course of the measurements certain sources of error were met with, so that the aim of the experiments was altered to a search for the causes of the discrepancies, in particular those due to the presence of water vapour. The influence of an admixture of hydrogen with the nitrogen is dealt with. It is found that with silver and with magnesium spark tracts the material composing the electrodes has an influence. With moderately dry gas the potential of the magnesium spark tract is some volts lower than that of the silver. With very good dryness, however, magnesium electrodes show a considerably higher spark potential than silver electrodes. A. E. G.

1682. Mechanism of the Arc Light. Part II. Glow Arc and Hissing Arc. H. Schmick and R. Seeliger. *Phys. Zeits.* 29. *pp.* 168–174, *March* 15, 1928.

The two classes of metal arc, complete arc and glow arc are discussed with reference to the experiments of Cady and of Hagenbach. Cady's experiments are repeated, and this leads to a confirmation of all his assertions. The transition from glow arc to complete arc is investigated with the iron arc. The limiting current strength as a result of the sudden change increases with increasing arc length, but it does not continue indefinitely; it reaches a maximum and then decreases again. It rises with diminishing pressure. The tension by which the sudden change results increases in an approximately linear fashion with increasing arc length. The tension drop which is connected with the sudden change also increases with increasing arc length. A comparison of the transition from glow arc to complete arc and from quiet to hissing arc shows that the limiting current strength is, in both cases, dependent in the same qualitative manner on the arc length, and also the tension by which the sudden change results increases in both cases in a linear manner with the arc length. These experiments show, as Cady has already pointed out, that the relationship of the hissing-current strength in an arc with a metal kathode and a carbon anode is the same as in a pure carbon arc ; on the other hand, in an arc with metal anode and a carbon kathode it is the same as in a pure metal arc. Further experiments are in progress. [See also Abstract 157 (1928).] A. E. G.

1683. Influence of Charged Metallic Points on the Spark Discharge. J. Thomson. *Phil. Mag.* 5. *pp.* 513–536, *March*, 1928.

Experiments are described showing that electromagnetic radiations emanate from the air in the immediate neighbourhood of charged metallic points from which electric discharges are taking place in air at atmospheric pressure. The intensity of the radiations increases with the intensity of the discharge. The radiations produce photoelectric effects as well as ionisation, and those giving rise to photoelectric effects emanate only from the neighbourhood of positively charged points. The ionising radiations emanate from the neighbourhood of both positive and negative points. The photoelectric radiations can penetrate 15 cm. of air, while the ionising radiations are absorbed by 3 cm. of air at atmospheric pressure. These results differ in some respects from those of C. E. Wynn Williams [see Abstract 1426 (1926)]. A theory is suggested of the action of a charged metallic point in facilitating the passage of a spark between spherical electrodes. This again differs from that put forward by Wynn

Williams in ascribing the greater part of the action to the photoelectric effect. The experimental results are discussed in relation to the theory of the spark discharge recently put forward by J. Taylor [see Abstracts 1848 and 1849 (1927)]; in general they support Taylor's theory. Modifications are suggested of some of Townsend's conclusions with reference to his theory of the spark discharge. A. W.

1684. Reunion of Ions and Electrons. J. Franck. *Zeits. f. Phys.* 47. 7–8. *pp.* 509–516, 1928. *Frank. Inst., J.* 205. *pp.* 473–479, *April,* 1928.

An hypothesis is here put forward that with ionisation processes the bound electron under radiation can be again imprisoned by the ion before it is removed from the sphere of influence of the atom. Such a reunion is possibly an explanation of the exciting function in the region of higher electron velocities. It is attempted to explain the observations of Langmuir on the origin of a Maxwell distribution of the velocity of kathode rays in highly ionised gases on the assumption of three kinds of collision, those occurring between positive ions, primary electrons and secondary electrons. A. E. G.

1685. Energy Distribution of Secondary Electrons from Copper, Iron, Nickel and Silver. H. E. Farnsworth. *Phys. Rev.* 31. *pp.* 405–413, *March,* 1928.

This is an extension of previous experiments [see Abstracts 1183 (1925) and 1891 (1926)]. An improved form of tube was used from which certain former disturbing factors were eliminated. The energy distribution curves show no evidence of the existence of inelastic collisions, but are found to vary with the metal and to be different for the metal before heating at red-heat than after. When the primary voltage is less than about 35 or 40 volts, which varies somewhat with the metal, there are practically no electrons escaping from the metal which have just sufficient energy to do so, but all have an energy of 0·5 equivalent volt or more in excess of that required to escape. A possible interpretation of this result is given. [See also next Abstract.] AUTHOR.

1686. Large Angle Scattering of Low-Velocity Electrons from Copper, Iron, Nickel and Silver. H. E. Farnsworth. *Phys. Rev.* 31. *pp.* 414–418, *March,* 1928.

The apparatus permitted a measure of the relative number of electrons leaving the target at angles between 163° and 179° with the primary beam. Measurements were taken at low primary voltages for which the number of emitted electrons is negligible, so that the electrons measured are primary electrons which have been scattered through large angles. For normal incidence the large angle scattering is greater than that necessary to satisfy the cosine law for the metals Cu, Fe, Ni, Ag after they have been heated at red-heat in a vacuum, and is different for each metal. Subsequent to baking the tube at 350° C., but previous to heating the target at red-heat, the large angle scattering is nearly the same for the four metals and approximately in accordance with the cosine law. The change in large angle scattering appears to be due to a change in the structure of the surface rather than to elimination of gas. For 45° incidence on a copper target, the scattering back in the direction opposite to that of the primary beam is less than for 90° incidence, but the direction of the surface normal is not the only determining factor in the scattering. [See also preceding Abstract.] AUTHOR.

1687. Secondary Electron Current as a Function of Crystal Structure. H. E. Farnsworth. *Phys. Rev.* 31. *pp.* 419–422, *March*, 1928.

A summary is given of results formerly obtained which indicate that the breaks in the low-voltage region of the secondary electron curve of a metal are characteristic of the arrangement of the atoms at the metal surface and not of the structure of the atoms themselves. Further evidence in support of this view is as follows: The secondary electron curve for phosphor-bronze containing 95·4 % copper does not show the characteristics of the curve formerly obtained for copper. The curve for targets cut from a single crystal of copper is distinctly different from that previously obtained for a large number of targets taken from copper sheet. Changing the angle of incidence of a copper target from 0° to 45° causes the changes in slope to be much less prominent, and changes the relative positions of some of the breaks. [See also preceding Abstracts.]

AUTHOR.

1688. Mean Free Path of the Alkali Ions in Different Gases. R. B. Kennard. *Phys. Rev.* 31. *pp.* 423–430, *March*, 1928.

Retardation and neutralisation of cæsium and sodium ions in traversing hydrogen, helium and argon.—With cæsium ions of 90-volt velocity in hydrogen there is very little neutralisation or scattering of the ions even when their path is twenty times the mean free path for a xenon atom in hydrogen. There is a loss of velocity of 1·3 volts per collision. Similar phenomena were observed in helium. Cæsium rays of 35 volts velocity in hydrogen are slowly weakened by neutralisation or scattering. Sodium ions of 455-volt velocity are also weakened in hydrogen, but the free path for a collision that removes the ion from the bundle is 26 times that of a neon atom in hydrogen. In argon, cæsium ions of 90-, 35- and 20-volt velocities are rapidly neutralised with a free path only 3·4, 2·6 and 2·3 times that of a xenon atom in argon.

AUTHOR.

1689. Electrical Fields near Metallic Surfaces. J. A. Becker and D. W. Mueller. *Phys. Rev.* 31. *pp.* 431–440, *March*, 1928.

When an electron escapes from a metallic surface it passes through fields which tend to pull it back. Properly directed applied fields partially neutralise the surface fields and hence reduce the work the electron has to do against these fields. That is why i, the thermionic current, increases steadily with F_a, the applied field. Quantitatively $d(\log_{10} i)/dF_a = (11600/2\cdot3T) \times s$, where T is the temperature of the surface and s is the distance from the surface at which the surface field F_s is equal to F_a. Hence the slope of an experimental log i vs. F_a curve at any F_a yields the value of s corresponding to F_s. For clean or atomically homogeneous surfaces experiment shows that the only force opposing the escaping electron is due to its image field; for composite surfaces other fields, which are ascribed to the adsorbed ions, are superposed on the image field. For 70 % thoriated tungsten this " adsorption field " is very large close to the surface and in a direction to help electrons escape; it decreases rapidly in strength as s increases until it is zero at about 15 atom diameters; here it reverses its direction and then increases in strength till it attains a maximum value of 8000 volts/cm. at 75 atom diameters; beyond this distance it decreases steadily. The intense field close to the surface accounts for the decreased work function, while the reverse field farther out accounts for the poor saturation at ordinary applied potentials. The photoelectric long wave-length limit should be shifted toward the red by applied fields. This shift should be particularly noticeable for composite surfaces. **Authors.**

1690. Electronic Discharge from Cold Wires in Intense Electric Fields. R. J. Piersol. *Phys. Rev.* 31. *pp.* 441–447, *March*, 1928.

Measurements were obtained for cold electronic currents at a pressure of 10^{-8} mm., using thoroughly outgassed electrodes made of a minimum amount of metal. A silver-plated glass cylinder served as an anode, with a coaxial tungsten filament kathode. Pure tungsten was used to avoid the changing surface conditions incident to outgassing thoriated tungsten. The gradient necessary for a given current was increased more than threefold by heating the filament for three hours at 2700° K., the approximate period necessary for maximum gradient. The type of current-gradient curve at room-temperature verifies the observations of Millikan and Eyring [see Abstract 1437 (1926)]. Effect of temperature on the discharge of electrons from wires in intense electric fields has been extended by a study of the current-gradient relationship at liquid-air temperature. These results show an intrinsic cold electronic phenomenon, possessing a type of current-gradient curve which has characteristics independent of temperature from 90° K. to 1000° K. **Author.**

1691. Theory of the Internal Action of Thermionic Systems at Moderately High Frequencies. Part I. W. E. Benham. *Phil. Mag.* 5. *pp.* 641–662, *March*, 1928.

Equations are given applying to a parallel plane thermionic system subject to potentials varying in time. These equations are similar to Child's equations for steady potentials, but contain extra terms. A solution is obtained for the alternating case, taking into account space-charge but neglecting emission velocities, in the special case of a small oscillatory potential superimposed on a large steady potential. The time of transit of the electrons appears in the solution. The theory is used to explain certain experimental results on the frequency variation of rectified current [see Abstract 1376 (1928)]. Though the qualitative agreement between theory and experiment is satisfactory, the observed effect is much the greater. The author discusses the discrepancies between theory and experiment. One of these is the apparent non-dependence of frequency variation on anode potential. To account for discrepancies the working hypothesis is adopted: That the electrons take a certain time to escape from the proximity of the filament, this time being determined by the temperature of the filament, but hardly at all by the anode potential. It is pointed out that electrons emitted with certain velocities are liable to execute a to-and-fro motion about the surface of minimum potential. This effect would increase with the frequency, with a corresponding modification of rectified current. **J. J. S.**

1692. Photoelectric Properties of Platinum. L. A. Dubridge. *Phys. Rev.* 31. *pp.* 236–243, *Feb.*, 1928.

In extending results previously reported [see Abstracts 1905 (1926) and 2124 (1927)], the photoelectric and thermionic work functions for platinum were studied while the specimen was put through an extended outgassing process. With monochromatic light the final value of the photoelectric threshold was found to be 1926 Å. (6·35 volts). The thermionic work function increases during outgassing, reaching a final value of 6·35 volts within 1 %. The two work functions are thus in agreement within the limits of error. The thermionic constant A of the Richardson T^2 law also increases as the work function increases, reaching a final value which is 200 times or more greater than Dushman's theoretical value of 60·2 amp./cm.^{2} deg.^{2}. E. E. F. d'A.

1693. Photoelectric Threshold Frequency and Thermionic Work Function. R. H. Fowler. *Roy. Soc., Proc.* 118. *pp.* 229–232, *March* 1, 1928.

Sommerfeld's revived electron theory of metals regards the interior of a metal as a region of uniform potential; the electrons form an almost perfect gas, but are nearly tight packed and obey the Fermi-Dirac statistics. When a quantum of ν-radiation strikes the metal and is absorbed by one of the "free" electrons of energy ϵ, this has the total energy $h\nu + \epsilon$, and can escape with energy ϵ', where $\epsilon' \leqslant h\nu + \epsilon - \chi_0$, χ_0 being the work required to extract an electron from rest in the metal to rest at infinity. A graph is given which shows the numbers of electrons in the metal with different amounts of energy ϵ. The number drops suddenly to zero for a certain value of ϵ, actually along a violent exponential curve; this accounts for the sharpness of the photoelectric threshold frequency. A note added to the paper makes use of Nordheim's theory of the reflection coefficient r to arrive at the effect of this factor in modifying the distribution law $n(\epsilon')$ for the emerging electrons. The final result obtained appears to be in excellent quantitative agreement with the observed distribution curves of photoelectrons. H. N. A.

1694. Oscillating Crystal. K. Sixtus. *Zeits. f. tech. Phys.* 9. 2. *pp.* 70–74, 1928.

The static characteristic of a zincite steel combination is investigated for different conditions, and a formula for the characteristic is advanced. The inferences from the formula agree with the experimental conclusions, the reason for the falling characteristic being attributed to the thermal phenomena at the contact point. Oscillograms of current and voltage with time give curves similar to those of the oscillating arc. E. T. A. R.

1695. Oscillations of Higher Order of an Oscillating Circuit. (Miss) M. Chenot. *Comptes Rendus*, 186. *pp.* 743–745, *March* 19, 1928.

Rayleigh's formula for the waves of a vibrating string to which a mass M is attached at one end, the other end being fixed, *viz.*, $\cot 2\pi L/\lambda = 2\pi M/\lambda\rho$, where L is the length of the strong and ρ its mass per unit length, gives waves of higher orders which are not harmonics. In this paper an analogous case is described in detail for electrical oscillations. H. H. Ho.

1696. Propagation of Electromagnetic Waves. H. Benndorf and A. Székely. *Zeits. f. Hochfrequenztechn.* 31. *pp.* 43–45, *Feb.*, 1928.

A new derivation is given of the formulæ for the conductivity and the dielectric constant of an ionised gas, the formulæ obtained being identical with those deduced by Salpeter by a different method. Numerical values for the conductivity and dielectric constant at different heights in the atmosphere, calculated from Salpeter's formula, are in good general agreement with those given by Elias [see Abstract 1647 (1926)], so that the conclusions drawn from his results can be regarded as essentially correct.

A. W.

1697. Theory of the Propagation of Electromagnetic Waves Over the Surface of the Earth. R. Weyrich. *Ann. d. Physik*, 85. 5. *pp.* 552–580, *March* 19, 1928.

In the ideal case considered, the propagation of electromagnetic waves in a parallel slab of dielectric between perfectly conducting planes (the earth's surface and the lower boundary of the Heaviside layer) is investigated, the source of radiation being a Hertz dipole with its axis along a normal to the slab surfaces and situated at some point within the slab. The dielectric slab is assumed to have also conducting and magnetic properties. The solution for the Hertz function is obtained as an integral of a product of a Bessel function and an expression involving hyperbolic functions. The paper is principally concerned with working out the mathematical relations of this solution, in particular for the case when resonance phenomena occur. Points of interest in connection with wireless telegraphy are indicated. W. S. S.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1698. Variation of the Resistivity of Thin Layers of Platinum. A. Féry. *J. de Physique et le Radium*, 9. *pp.* 38–48, *Jan.*, 1928.

Kathodic projections were made use of to determine the variation in the resistivity of Pt as the thickness of the metallic layer varied. First the linear relation $a = 6\cdot34 \times \mathrm{D}$ was established, a being the thickness of the layer of Pt in micromillimetres ($1\ m\mu = 10^{-7}$ cm.) and D its optical density. Thus the thickness of the deposits could be determined by measuring their opacity with the microphotometer. Care was taken to avoid the influence of water vapour, and resistances were obtained which remained stable during more than a year. For the thicknesses investigated (between $4\cdot4\ m\mu$ and $243\ m\mu$) the resistivity ρ of the deposits varied considerably with the thickness according to the numerical law: $\log (10^5\rho) = 5\cdot7 - 0\cdot0156a$, a being measured in $m\mu$ and ρ in ohm/cm. It appears that the deposits reassume the resistivity of the metal at a thickness of about $366\ m\mu$. Adsorption of vapour of water by the projection of Pt augments considerably the resistance of the layer. Bodies rich in O (SO_2, CH_3OH), analogous in their electrical behaviour to water, produced by their adsorption similar effects to those of water vapour, but the increases of resistance were unequal, the maximum values attained being in the order of the specific inductive powers of the vapours at the temperature considered. The hypothesis that the deposit is not homogeneous and that the particles are separated by arbitrarily arranged fissures will not explain the phenomena observed, and the author considers that the effects are due to surface action. For feeble thicknesses (between 11 and 600 atomic diameters) the deposit does not possess the same internal structure as the compact metal. The surface effect becomes apparent when the thickness approaches the reticular dimensions of the crystalline lattice. For a thickness of 600 atoms the deforming action exerts its influence up to the centre of the layer. J. J. S.

1699. Measurement of the Electrical Resistance of Porous Materials. A. E. Knowler. *Phys. Soc., Proc.* 40. *pp.* 37–39; *Disc.*, 39–40, *Feb.*, 1928.

A method is described whereby the resistance of a material is measured independently of that at the surfaces in contact with it. The method is specially suited to the measurement of the resistance of ceramic, refractory, and building materials. Results show that the conductivity of a building stone is nearly proportional to its moisture content. AUTHOR.

1700. Conduction of Electricity in Quartz. A. D. Goldhammer. *Zeits. f. Phys.* 47. 9–10. *pp.* 671–690, 1928.

The passage of electricity through quartz shows peculiarities not found in the case of other dielectrics. The differing conductivity of quartz along the optic axis and perpendicular to it was pointed out by J. Curie. There exists in this substance what A. Joffé has called a "hardening," which consists in the following behaviour: If a previously heated quartz plate is quickly cooled, there occurs a change in its conductivity which is not simultaneous with the cooling, but is delayed (and the final value at the new temperature is only attained after a somewhat long interval of time), and the value depends on the temperature difference and on the absolute value of the lowered temperature. In the present paper, which is divided into an experimental and theoretical part, Curie's results are confirmed. Three plates of crystalline quartz were observed during the interval between 0·01 sec. and 10·0 sec. after the application of a current. The decrease of current observed in the first few moments seems to be due to a counter e.m.f. which is set up, whose cause does not consist in the formation of space-charges in the crystal. The falling-off of the current to approximately 0·2 of its initial value was observed. The origin of the decrease noticed is probably related to the falling-off observed by Schaposchnikow and imputed by him to be due to saturation currents in the quartz. After passage of the current through the crystal, its conductivity, measured by the initial current, increases. This increase in the case of a fresh crystal consists of two parts, one constant and irreversible and one temporary, which falls to zero after some hours. The temporary increase of conductivity is unipolar and is greater along the direction of the current. Slow processes of decrease of the conductivity raised by passage of a current or exposure to X-rays agree well with formulæ deduced from the theory of ions. A portion of this research was carried out in the Physico-Technical Röntgen Institute in Leningrad. J. J. S.

1701. Dispersion of Conductivity and Dielectric Constants of Strong Electrolytes. P. Debye and H. Falkenhagen. *Phys. Zeits.* 29. *pp.* 121–132, *March* 1, 1928. *Paper read before the Deut. Phys. Gesell., Halle, Jan.*, 1928.

It is shown that there exists for the mobility of ions in strong electrolytes a "relaxation period," which is of great importance for the dispersion of the conductivity and for the dielectric constant. The theory is developed mathematically and discussed from the following points of view: (1) The part played by the "relaxation period" in the non-stationary state; (2) dispersion of the action of forces originating in the ionic mist; (3) dispersion of the conductivity and the dielectric constants. F. J. B.

1702. Electromagnetic Actions of Conductors in the Interior of Masses with High Magnetic Permeability. B. del Nunzio. *Ann. R. Scuola Ing., Padova,* 3. *pp.* 123–125, *June,* 1927.

This note has for object the determining of the laws which govern electromagnetic actions when conductors are placed in the interior of masses of material which possess great magnetic permeability, and the endeavour is also made to find the conditions under which it is permissible to extend to this particular case the classic theoretical laws. The case of a conducting wire placed in a magnetic field with its axis at right angles to the lines of force of the field and surrounded by a cylindrical tube of ferromagnetic substance is considered and expressions obtained for the density of the magnetism induced on the cylinder and for the normal components of the electromagnetic force. Experimental verification of the results reached is obtained by use of a sort of electromagnetic balance. J. J. S.

1703. Application of the Debye Dipole Theory to Binary Liquid Mixtures. J. W. Williams. *Phys. Zeits.* 29. *pp.* 174–181, *March* 15, 1928.

The author applies the Clausius-Mosotti relationship extended by Debye to the calculation of electric moments from the dielectric constants and densities of suitable binary liquid mixtures. Comprehensive tables are included in the paper, the molecules being divided into two groups according as they are polar or dipole free, whilst a third group of doubtful dipole molecules is included. It is established that, within the limits of experimental error, the molecular polarisation, and with it the electric moment of a dissolved molecule, is independent of the dipole free solvent. The dipole moment is shown to give a quantitative measure of the polarity of the molecule. The significance of such measurements in various fields of chemistry and physics is discussed. H. H. Ho.

1704. Electric Moment of the Water Molecule. J. W. Williams. *Phys. Zeits.* 29. *pp.* 204–205, *April* 1, 1928.

For a more exact determination of this constant the author has employed his previous method of dilute solutions [see preceding Abstract], and for the purpose has used a saturated solution of water in benzene. Owing to the slight solubility, the method requires to be very exact. The dielectric constants of benzene and of the solution were found to be $2\cdot282 \pm 0\cdot001$ and $2\cdot294 \pm 0\cdot001$ respectively; the molecular polarisation of water from known data worked out at 64 ± 4 cm.^{3}, and the electric moment was calculated to be $\mu = (1\cdot70 \pm 0\cdot06) \times 10^{-18}$. This value is almost identical with those for the lower alcohols and for phenol, all of which are substances whose dissymmetry is caused by an $-$ OH group. H. H. Ho.

1705. Dielectric Constant of Liquid Bromine. Anne I. Anderson. *Phys. Soc., Proc.* 40. *pp.* 62–67; *Disc.,* 68–70, *Feb.,* 1928.

An account is given of a redetermination of the dielectric constant of liquid bromine, the value found being 3·12 at 15° C., and at a frequency of 187,000 per sec., with a temperature coefficient of $-0\cdot00191$ referred to 0° C. Applying the dipole theory of Debye and Gans to the results, a value of $0\cdot40 \times 10^{-18}$ is deduced for the electric moment of the bromine molecule Br_2. The electrical conductivity was also measured. AUTHOR.

1706. Temperature Dependence of the Dielectric Constants of Gases and Vapours. Part I. H. A. Stuart. *Zeits. f. Phys.* 47. 7–8. *pp.* 457–478, 1928.

In this paper measurements are described showing the temperature dependence of carbon dioxide and air between 0° and 180° to an accuracy of 2 %. No electric moment was found for carbon dioxide. With air a small increase of molecular polarisation occurred which appears to have its analogy in a corresponding rise of molecular refraction. From the absence of an electric moment, it follows that in the molecule of carbon dioxide the three atoms lie in a straight line, and it is shown that this result follows from electrostriction and other measurements. **Errata,** *ibid.* 48. 5–6. p. 448, 1928. [See also Abstract 2387 (1926).] H. H. Ho.

1707. Dielectric Constants and Electrostatic Fields. F. Kautzsch. *Phys. Zeits.* 29. *pp.* 105–117, *Feb.* 15, 1928.

The molecular moments (Debye's kinetic theory of dielectrics) measured for ethyl-ether, chloroform and chlorobenzol. In ethyl-ether and chloroform saturation-phenomena observed in the changes of dielectric constants brought about by electrostatic fields. Comparisons with the results of Herweg and Pötzsch [see Abstract 1378 (1922)] for ethyl-ether. Calculation of the Kerr constant for slow electric oscillations, which passes into Lyon's value for optical oscillations. A. D.

1708. Dielectric Behaviour of Glass in A.C. Circuits. Part I. Relation of Power Factor and Dielectric Constant to Conductivity. Louise S. McDowell and Hilda Begeman. *Phys. Rev.* 31. *pp.* 476–481, *March,* 1928.

Power factor, dielectric constant at 1000 cycles and apparent resistivity for six glasses of varying composition, both lead glasses and borosilicates with and without lead, all at 20° C. The values of the apparent resistivity at 20° C. were found by linear extrapolation, by means of the equation $\rho = e^{k/T}$, from values of the apparent resistivity calculated from measurements of the resistance of small rods at temperatures ranging from 100° C. to 500° C. In two cases studied the power factor of strained samples was about 50 % greater than after annealing. No explanation is offered. For glasses of relatively similar composition both the power factor and the dielectric constant are found to increase with increasing conductivity. The results indicate a close relation between the phenomena of absorption and of ionic conductivity, and are shown to be qualitatively in agreement with the theory of Joffé that the phenomena of absorption are due to a counter-electromotive force of electrolytic polarisation. Possible alternative molecular explanations are suggested. AUTHORS.

1709. Pyro- and Piezoelectricity of Pentra-erythrite. H. Mark and K. Weissenberg. *Zeits. f. Phys.* 47. 3–4. *p.* 301, 1928.

A note on the pyroelectric and piezoelectric peculiarities of pentra-erythrite as determining the category of crystals in which it is properly to be placed. J. J. S.

1710. Deformations and Changes of Optical Properties of Quartz under the Influence of an Electric Field. N. T. Ze. *J. de Physique et le Radium,* 9. *pp.* 13–37, *Jan.,* 1928.

After a summary and discussion of previous work on this subject, the author describes his experiments in the laboratory of C. Fabry in Paris. An electric field was set up along the direction of the binary axis of a rectangular parallelopiped of piezoelectric quartz. (1) The piezoelectric deformation in the direction normal to the optical and electric axes was measured with potentials varying from 200 to about 40,000 volts. Up to 3000 volts the deformations appeared to be proportional to the tensions, and the piezoelectric constant established by Curie holds good. But for great differences of potential a new fact appeared: the deformation does not increase proportionally to the potential, but appears to tend towards a limit, which seems to be situated at a p.d. of about 160,000 volts. (2) In the direction of the electric axis the deformation was multiplied by working with a set of thin layers of quartz made up into a pile. The deformation per unit of length is equal and of contrary sign to that which is produced in the direction normal to the optical and electric axes. (3) Dielectric deformations of quartz were also observed: a contraction in the direction of the lines of force, and a lengthening in the perpendicular directions. These are proportional to the electric energy per unit of volume of the condenser, and yet do not seem capable of explanation by the ordinary electrostatic pressures. (4) Measurements were made of (*a*) the variations of the indices of the ordinary and extraordinary vibrations in the direction of the electric axis and the variation of the birefringence in the same direction; (*b*) the variation of the birefringence in the direction normal to the optical and electric axes. These optical modifications are linear and change sign with the direction of the electric field. They cannot be considered as secondary effects due to electric dilatations. An electro-optical phenomenon seems to be in evidence. J. J. S.

1711. Saturated Photoelectric Current in Crystals. W. Flechsig. *Zeits. f. Phys.* 46. 11–12. *pp.* 788–797, 1928.

Referring to the distinction drawn by Gudden and Pohl between crystals of high and of low refractivity [see Abstract 2490 (1923)], crystals of rock-salt are examined for signs of a saturation of the photoelectric current. Theory indicates that such saturation would require 600,000 volts for 1 millimetre of thickness. The saturation voltage varying as the square of the thickness, specially thin plates are required. The author describes the cutting of plates down to 0·1 mm., their silvering for electrodes, and their exposure to light in a vacuum. The curves obtained show a distinct saturation at about 1000 volts for thin plates, and a gradual approximation to Ohm's law as the thickness increases. E. E. F. d'A.

1712. Thermoelectric Phenomena in Crystals. P. W. Bridgman. *Phys. Rev.* 31. *pp.* 221–235, *Feb.*, 1928.

When an electric current passes across an interface where the crystal orientation changes there is a Peltier heat, but no corresponding jump of potential. The author finds it necessary to distinguish between the "working" e.m.f. and the "driving" e.m.f., and gives an expression for the thermal energy conveyed by the current and the manner in which it depends upon the direction of the latter. The existence of an internal Peltier heat when the direction of the current is changed is of importance even in isotropic substances. Some fine structure seems to be demanded in a metal which is not ordinarily taken into account. E. E. F. d'A.

1713. Description of the Exhibits at the Eighteenth Annual Exhibition of the Physical and Optical Societies. Scientific Electrical Instruments. E. H. Rayner. *Journ. Sci. Instruments,* 5. *pp.* 54–58, *Feb.,* 1928.

Brief details are given of the characteristic features of three Duddell oscillographs for 3-phase operation at 75,000 volts between the vibrators, a Cambridge wave-form indicator, a low-tension Schering bridge for determination of capacitance and dielectric loss of insulating materials at audio-frequencies, an improved Campbell mutual inductometer, an apparatus for automatic humidity control, a temperature deviation indicator, a simpler form of Wilson-Shimizu cloud expansion apparatus, a high-tension bridge for comparison of the insulation of cables, etc., with that of an air condenser, an apparatus for testing permanent magnets, a precision variable condenser for wavemeter purposes, a thermojunction current detector, a precision wavemeter for short waves, high-class laboratory instruments and modern vacuum pumps and apparatus.

R. S. R.

1714. Description of the Exhibits at the Eighteenth Annual Exhibition of the Physical and Optical Societies. Commercial Instruments. A. C. Jolley. *Journ. Sci Instruments,* 5. *pp.* 58–63, *Feb.,* 1928.

The most notable features are stated to be the extended use of cobalt chrome steel and of mumetal in instrument construction, the employment of the thermojunction for measurement of direct current and of alternating current up to radio frequencies and the development of the induction pattern ammeter as an instrument of precision. Among individual instruments described are a recording potentiometer for the accurate measurement of small potential differences, a thermoammeter designed to eliminate the unsteady zero and large reversal error, a portable multi-range ammeter and voltmeter, a master-frequency meter which maintains the frequency of a power station almost perfectly constant, types of induction ammeters and voltmeters devised to reduce the temperature and frequency errors, and a direct-reading thermionic valve tester arranged to show the voltage amplification factor, the plate impedance in ohms, the mutual conductance in micromhos and the plate current. R. S. R.

1715. Description of the Exhibits at the Eighteenth Annual Exhibition of the Physical and Optical Societies. Wireless Apparatus. R. L. Smith-Rose. *Journ. Sci. Instruments,* 5. *pp.* 64–66, *Feb.,* 1928.

Brief reference is made to the exhibits of several firms of a large range of precision variable condensers and wavemeters, apparatus used for alternating-current measurements at audio- and radio-frequencies, valves of many varieties for transmission and reception and of various types of wireless sets. The vacuum thermocouple units for the measurement of small radio-frequency currents, modifications of Moullin's thermionic voltmeter and an apparatus to register distress calls or alarms on board ship are mentioned. R. S. R.

1716. Improved Form of Duddell Oscillograph Outfit. *Journ. Sci. Instruments.* 5. *pp.* 103–107, *March,* 1928.

A compact portable form of the Duddell oscillograph is described which is capable of being used for the investigation of many electrical engineering problems, and it is also adapted for teaching and demonstration purposes. A system of lenses is used to focus the light from the vibrating mirrors on to the photographic film, carried on a revolving drum. This enables the oscillations to be photographed with great sharpness. Typical oscillograms are given, one being the e.m.f. and current wave-forms obtained on an alternating current main at 75 volts, 50 cycles. A second oscillogram shows the operation of automatic telephone relays. F. J. B.

1717. Registering Apparatus for String Electrometer. W. Kolhörster. *Zeits. f. Phys.* 47. 5–6. *pp.* 449–453, 1928.

A description of an easily portable photographically registering apparatus, made by Günther & Tegetmeyer, Braunschweig, which can be attached simply to any instrument such as a string electrometer. Detailed drawings and photographs of the instrument are given. J. E.

ALTERNATING CURRENTS AND MAGNETISM.

1718. Influence of Magnetic Alternating Fields on the Motion of Electric Floating Particles. A. Kneschke. *Zeits. f. Phys.* 47. 7–8. *pp.* 608–614, 1928.

The differential equation system for the motion of an electric floating particle in a homogeneous magnetic alternating field is integrated, and the influence of such a field on the path of the particle investigated. With the aid of a moving trihedron the general differential law of motion is established in natural coordinates and the rotational vector (Darboux vector) of the accompanying trihedron calculated. E. F.

1719. Scientific Aspects of Intense Magnetic Fields and High Voltages. E. Rutherford. *Roy. Soc., Proc.* 117. *pp.* 300–316, *Jan.* 2, 1928. *Nature,* 120. *pp.* 809–811, *Dec.* 3, 1927.

It is not difficult, by means of modern electrostatic machines, to produce weak direct currents at 200,000 to 300,000 volts, and a large, well-insulated induction coil can give momentary voltages of a similar magnitude. For X-ray purposes, comparatively light transformers may be obtained which can supply the requisite current at 300,000 to 500,000 volts. Voltages of the order of 1,000,000 may be produced in the secondary of a Tesla transformer, and 5,000,000 volts are said to have been obtained in the Carnegie Institution of Washington. The Tesla coil is being applied, as a source of high voltage, to the testing of insulating materials. High voltages may also be obtained by a cascade method in which the secondary current of one transformer passes through the primary of a second, and so on. The plant gives a torrent of sparks several yards in length. The highest voltage so obtained (about 3,000,000 volts) is, however, small compared with that in a normal lightning flash from cloud to earth, which may be as high as a 1000 million volts. From the purely scientific point of view, these high potentials are regarded as means to obtain a copious supply of high-speed electrons and high-speed atoms. At present the natural source of these is radium. The α-particle from radium C is liberated with an energy of 7·6 million electron volts (energy acquired in a vacuum by an electron in falling through this p.d.). The swiftest β-rays from radium have an energy of about 3 million electron volts; and a voltage of more than 2 million would be required to produce X-rays of the penetrating power of γ-rays. Coolidge has constructed an electron tube which will stand 300,000 volts, the rays passing into the air through a thin plate of chrome-nickel-iron about 0·0005 in. thick. Using three such tubes in series, an intense beam of electrons is obtained which passes out into the air to a distance of about 2 metres from the window. The electrons per second in a current of 2 milliamperes would be equivalent to the number of β-rays emitted per second from about 150,000 gm. of radium. The energy of the single electrons is, on the other hand, less than that of the β-particles. The scientific aspect of intense magnetic fields is then discussed, and the electromagnets of Weiss, Cotton and Kapitza are referred to. That designed by Kapitza is capable of giving a field of 320,000 gauss over a volume of 3 c.c. G. E. A.

1720. Magnetic Induction. D. Graffi. *Accad. Lincei, Atti,* 6. *pp.* 595–601, *Dec.,* 1927.

A new mathematical treatment of the problem of magnetic induction in ferro-magnetic bodies regarded as a " hereditary " phenomenon. E. E. F. d'A.

1721. Diamagnetic Susceptibilities in the Liquid and Vapour States. V. I. Vaidyanathan. *Indian Journ. Phys.* 2. *pp.* 135–150, *Jan.,* 1928.

Diamagnetic susceptibilities appear to be affected by liquefaction. Does this mean that diamagnetism is not a purely atomic property? CS_2, benzene, pentane, and hexane were investigated as liquids and as vapours by the method of orientating a rod immersed in the medium. All showed a higher value for K in the vapour state. Some other liquids investigated showed no important change. This leads the author to believe that the phenomenon is real. It is discussed in the light of theories of diamagnetism, and the view is expressed that atomic and electronic movements are not exactly the same in the different states. [See next Abstract.] A. C. M.

1722. Diamagnetic Susceptibilities of Gases at Low Pressures. V. I. Vaidyanathan. *Phil. Mag.* 5. *pp.* 380–386, *Feb.,* 1928.

A thin closed bulb of glass was suspended from a torsion-balance beam in a suitable non-homogeneous magnetic field, and the gas under test surrounded the bulb. Strict proportionality was found between the pressure and the volume susceptibility at low pressures. The relative values were $-0{\cdot}00092 \times 10^{-6}$, $-0{\cdot}00113 \times 10^{-6}$, and $-0{\cdot}00058 \times 10^{-6}$ for the volume susceptibilities of CO_2, A, and N_2 respectively at 0° C. and 760 mm. (air $= 0{\cdot}0308 \times 10^{-6}$). The relative values are accurate to within about 5%. A. C. M.

1723. Magnetic Permeability of Nickel in Feeble Oscillatory Fields. R. G. Loyarte. *Univ. Nac. La Plata, Estudio Ciencias, No.* 82. *pp.* 209–216, 1928.

Several authors have suspected a very pronounced maximum in the magnetic permeability of iron for feeble oscillations of a wave-length of 100 metres, but the work of Wait has shown the effect to be spurious. The author therefore examines the result announced by Israel according to which the permeability of nickel shows a complicated structure between the wave-lengths of 28 and 60 cm. He shows that it is also spurious, and is due to the dependence of the damping upon the period. E. E. F. d'A.

1724. Extension of Langevin's Theory of Atomic Magnetism. S. S. Bhatnagar and C. L. Dhawan. *Phil. Mag.* 5. *pp.* 536–545, *March*, 1928.

Joos [see Abstract 2366 (1925)] pointed out that molecules of the same number of electrons in the same configuration should have similar properties. For the ionic or atomic diamagnetic susceptibilities of Cl^-, A, K^+, atomic numbers 17, 18, 19, he calculated the values 19·5, 17·5, $15·5 \times 10^{-6}$ in agreement with experiments. The authors extend this to atoms of families of elements and to compounds and electronic isomers, *i.e.*, molecules of the same sum of the numbers of electrons (*e.g.* NACl 28, CaO 28). He calculates the atomic and molecular radii on W. L. Bragg's views of close packing. The atomic numbers of Cl, Br, I are 17, 35 and 53, and the susceptibilities 19·5, 32·0, 45·7, the susceptibility increasing with the atomic number. For the carbonates of Ba, Sr, Ca, Mg the experimental susceptibilities are 43·4, 25·25, 14·01, 6·99 and the calculated radii of the molecules 2·193, 2·056, 1·836, 1·620; the susceptibility decreases as the radius decreases. When Langevin's formula for the susceptibility is written $\chi_m = -2{\cdot}85{\cdot}10^{10} \Sigma (kr)^2$, the arbitrary constant k is, for isomorphous series and electronic isomers, found to decrease, in the case of the carbonates just mentioned from 1·98 to 0·98, and to be identical for isomers, both inorganic and organic, being, *e.g.*, 1·0 for NaCl and CaO, 3·497 for ethyl aniline and dimethyl-aniline, and 3·271 for aniline and glycerine. H. B.

1725. Magnetic Moment of the Cupric Ion. Paule Collet and F. Birch. *Comptes Rendus*, 186. *pp.* 499–501, *Feb.* 20, 1928.

Copper tends to form complex ions in solution, which may have different magnetic moments. For the simple phenomenon χ the coefficient of magnetisation must vary with the temperature linearly, though linear variation may not necessarily imply that the phenomenon is simple. The authors have examined cupric salts under different conditions, and between different temperature intervals where the above condition was satisfied. A table gives the Curie points, θ, and Curie's atomic constants for the different cases, and the number of magnetons in the ion is calculated for each case. The moment approximates to ten magnetons in six cases, to nine in one, while for anhydrous $CuCl_2$ there are five measurements close to 9·6, one of 9·11, and two of 9·76. It is uncertain whether 9·6 is really one of the moments of Cu'', or if this is due to a mixture of different carriers.

H. N. A.

1726. Different Magnetic States of the Cobaltous Ion. A. Chatillon. *Ann. de Physique*, 9. *pp.* 187–260, *March–April*, 1928.

A research on the atomic susceptibility of cobalt ($Co^{\cdot\cdot}$) in the chloride and sulphate. Cabrera and Trümpler had found that this ion exists, in aqueous solutions, in two different magnetic states. Of these, one state is stable and is characterised by an atomic moment of 25 magnetons, and a negative Curie point constant at − 12° abs. The ion is found to contain 23 magnetons when the chloride is in alcoholic solution. The ion in anhydrous sulphate possesses 25 magnetons when dehydrated below 400° C., but contains 26 magnetons if dehydrated above 600° C. The cobaltous chloride in aqueous solutions to which HCl has been added is found with moments of 22, 23, 24 and 25 magnetons. G. E. A.

1727. Magnetic Susceptibility of Thin Layers of Manganese. H. Freese. *Phys. Zeits.* 29. *pp.* 191–197, *April* 1, 1928.

It is not yet possible to state definitely whether manganese, neighbour to the iron group in the periodic system, is ferromagnetic as well as paramagnetic. It appears to exist in both forms, Weiss and Onnes and others having observed a ferromagnetic variety [see Abstract 735 (1910)]. It is supposed that the presence of hydrogen is responsible for the high susceptibility. Manganese was prepared for magnetic testing (*a*) from $MnCl_2$ by Kuh's method which is fully detailed, (*b*) by electrolysis, and (*c*) by pulverisation in a hydrogen vacuum tube. On testing the material qualitatively, the author was unable to reproduce Kuh's results entirely. Measurements by the Curie-Weiss method gave, for Mn prepared by method (*c*), mass susceptibilities from 70×10^{-6} to 12×10^{-6}, whilst method (*b*) gave values between 20×10^{-6} and 9×10^{-6}. These are of normal paramagnetic dimensions, and the expected high susceptibility was not obtained. A useful bibliography concludes the paper. G. E. A.

1728. Temperature Relationship of Residual Magnetism. H. Gewecke. *Zeits. f. tech. Phys.* 9. 2. *pp.* 57–60, 1928.

The paper gives the experimental results regarding magnetic materials with small temperature coefficients for residual magnetism. The directions as to procedure for making further measurements on other materials are given fully. The work of Ashworth and the consequences of his theory are discussed at length. S. G. B.

1729. Thermomagnetic Study of Some Iron Minerals. J. Huggett and G. Chaudron. *Comptes Rendus*, 186. *pp.* 694–696, *March* 12, 1928.

The authors have previously shown [see Abstract 1894 (1927)] that the three oxides of iron possess anomalous magnetic characteristics, and the work is now extended to certain iron minerals in which the nature of the magnetic constituents is unknown. Data and curves are given for magnetite, goethite, oligiste, martite, and lepidocrocite. H. H. Ho.

1730. Interpretation of Paramagnetism in the Iron Group. O. Laporte. *Zeits. f. Phys.* 47. 11–12. *pp.* 761–769, 1928.

The formula given in an earlier paper by Sommerfeld and Laporte [see Abstract 1267 (1927)] for the susceptibility contained the resolution of the fundamental terms of the spectra of the ions concerned. These authors established that the strict validity of the Curie law depended essentially on the grouping of the levels of the separate paramagnetic molecules or ions. Van Vleck [see Abstract 2757 (1927)] from the standpoint of the wave mechanics showed how the Langevin law for paramagnetism and also the analogous Debye formula for molecular refraction could be derived. In the present paper the resolution is calculated by means of the relativity doublet formula. These purely spectroscopically obtained magneton numbers are not found to agree in any case with the observed values. The same effect has been noticed for the rare earths, and various possible explanations of this discrepancy are now discussed.

H. H. Ho.

1731. Earth-Resistivity Measurements in the Copper Country, Michigan. W. J. Rooney. *Terr. Mag.* 32. *pp.* 97–126, *Sept.–Dec.*, 1928.

During the summer of 1927 the Department of Terrestrial Magnetism of the Carnegie Institution of Washington and the Michigan College of Mines and Technology engaged in conducting jointly a series of earth-resistivity measurements in the Copper Country of northern Michigan, where the geological structure is well known, to determine the value of measurements of resistivity and its variations as indications of the geological structure below the surface. The work done may be roughly divided in two parts: First, measurement and study of the variations in resistivity with depth, or with volume, to establish such general relations as exist between the two; and, second, the determination of the resistivity of specific rock-flows, in order that more fundamental data be made available as an aid to the interpretation of the results of the former type of measurement. The results of the first part of the investigation bear out the evidence from previous work that resistivity determinations may be used to advantage in determining the location of certain underground discontinuities. The data obtained in the second part on the resistivity of specific rocks are also in line with previous results. The resistivity of porous, sedimentary rocks was usually under 20,000 ohms per centimetre cube, while traps and associated rocks of volcanic origin were found to have resistivities from five to twenty times as great. AUTHOR.

1732. Periodicity of Sunspots and Earth Magnetism. W. B. Schostakowitch. *Terr. Mag.* 32. *pp.* 133–138, *Sept.–Dec.*, 1927.

It is shown that the following magnetic elements (*a*) horizontal force, (*b*) declination, (*c*) magnetic activity all possess (in addition to the 11-year period) additional periods of 33·1, 5·8 and 3·2 years. These periods are also present in sunspot activity. A. A. D.

1733. Cause and Propagation of Magnetic Storms. L. Rodés. *Terr. Mag.* 32. *pp.* 127–131, *Sept.–Dec.*, 1927.

The view is advanced that storms are due to the entry of the earth into clouds of electric particles projected from the sun. Thus the storm will be first registered at those observatories that are nearer the front meridian [see Abstract 845 (1923)]. Certain objections to this view have been made by Bauer and Peters, who concluded that the phenomena are not compatible with as slow a rate of progress as this theory demands. It is here suggested that owing to gravitational and electrostatic forces the clouds may be attracted by the earth and the progress of the storm speeded up. Further evidence is provided by observations made at Ebro, showing the relationship of frequency of calm and stormy days with the earth's heliographic latitude. A. A. D.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

1734. Type of Muscular Contraction with Indirect Excitation with Linear Currents. P. Fabre. *Comptes Rendus*, 186. *pp.* 170–171, *Jan.* 16, 1928.

It has been shown [see Abstract 744 (1928)] that preparations of the frog's gastrocnemius muscle lose their response to slowly increasing direct currents as the specimen ages. The variations of response to such currents when the nerve is intact are now discussed. B. J. L.

1735. Direct Excitation of Muscle by Progressively Increasing Currents. P. Fabre. *Comptes Rendus*, 186. *pp.* 400–401, *Feb.* 6, 1928.

Previously [see Abstract 744 (1928)] the author has discussed the reaction of the frog's sciatic nerve towards increasing direct currents. Further experiments are now described, using the gastrocnemius muscle. The type of curve of the response and current value for muscle tissue is described. Unlike the case of nerve tissue, muscle tissue shows no considerable variation with the age of the specimen. The nature of the muscle response is discussed, and the relation of the linear constant with respect to chronaxy. The author concludes that the ageing effect with a dissected nerve tissue is due to the results of dissection, and perhaps a general action upon the whole of the nervous apparatus. B. J. L.

1736. Heat Disengaged by Porous Electrodes in d'Arsonval Diathermy. The Great Inconvenience of these Electrodes. Bordier. *Comptes Rendus*, 186. *pp*. 540–542, *Feb*. 20, 1928.

D'Arsonval [see Abstract 3213 (1927)] has suggested that high-frequency diathermy currents are affected by colloids or human tissues as though these acted sometimes as a resistance and sometimes as a capacity. Fabry [see Abstract 462 (1928)] has shown that the resistance effect alone heats the tissues, the capacitative currents being wattless. This is the cause of discrepancies in instrument readings. The present author has experimented as to the heat variation with different concentrations of the salt solution with which the electrodes are damped, and finds the diathermic heat effect is greatest with weak solutions. The effect varies with the porosity of the electrode covering, and whilst a large current may be passed for a long time with electrodes covered by a porous medium, the physiological effect is less than that due to a smaller current of shorter duration with plain metallic electrodes. This is stated to be due to the presence of a large condensative wattless current, and hence milliampere readings are no criterion of the medicinal effects. The use of plain metallic electrodes is advocated. B. J. L.

1737. Automatic Test for Skin Sensibility. J. Saidman. *Comptes Rendus*, 186. *pp*. 543–545, *Feb*. 20, 1928.

Ultra-violet apparatus, even if of the same wave range and intensity, gives varying results of erythema, apparently dependent upon individual idiosyncrasy. Hence, purely physical measurement is of little use in the medical application of ultra-violet light. The method of determining the correct skin reaction by multiple windows is described. The author utilises an automatic obturator with eighteen orifices, and so removes the need of personal manipulation. The eighteen orifices are grouped in two circles, and exposed in sequence by a clockwork. The apparatus can also be utilised to determine the effect of sensitising bodies upon erythema production and the lethal anti-bacterial effects, etc. B. J. L.

CHEMICAL PHYSICS AND ELECTROCHEMISTRY.

1738. Geometric Character of Specific Molecular Compounds. Colloidal Adsorption. R. Ferrier. *Comptes Rendus*, 186. *pp.* 577-578, *Feb.* 27, 1928.

Certain colloids precipitate one another from their solutions, and this reciprocal adsorption is specific within narrow limits and need not take place in similar solutions, though they do not differ in their chemical properties. When proteins are hydrolysed into amido-acids, these acids unite, under elimination of water, to chain compounds of indefinite length with ramifications. The decisive feature for the union is not the chemical nature, but the geometric configuration of the radicles which must admit of polygonal arrangement of groups in the reversed sense. No substance can be precipitated upon itself in the same sense. H. B.

1739. Size-Distribution of Colloidal Particles. N. Rashevsky. *Phys. Rev.* 31. *pp.* 115–118, *Jan.*, 1928.

A colloidal solution, which contains particles of various size, is considered to be thermodynamically similar to a solution containing various kinds of dissolved molecules. Planck's expression for the characteristic function of such a solution is then applied. The characteristic function happens in this case to depend on the distribution-function of the size of particles. That distribution is considered actually to occur which makes the characteristic function an extremum and is determined in the usual way. The theory applies only to dilute colloidal solutions. AUTHOR.

1740. Method for the Measurement of Gases Dissolved in Water. L. Dunoyer. *J. de Physique et le Radium*, 9. *pp.* 1–12, *Jan.*, 1928.

This method consists in introducing a small quantity of water into a high vacuum, the water vapour being absorbed either by phosphoric anhydride or by a trap immersed in a mixture of acetone and solid carbon dioxide. The water immediately freezes, liberating all the dissolved gas, the pressure of which is measured by a McLeod gauge; the water afterwards evaporates extremely slowly. If more than a certain amount of water is used, the liberated gases are partially absorbed, so that no more than 1 or 2 c.c. should be taken. The accuracy of the pressure measurements is about 1 or 2 %. Phosphoric anhydride is the best absorbent, since the use of carbon dioxide and acetone leads to complex results, which are being further considered. The rapidity of absorption of the water vapour by the anhydride diminishes quickly as the hydration of the absorbent proceeds, but even when the hydration is evidently considerable, the residual water vapour has very slight pressure. T. H. P.

1741. Solubility of Hydrogen in Silver. E. W. R. Steacie and F. M. G. Johnson. *Roy. Soc., Proc.* 117. *pp.* 662–679, *Feb.* 1, 1928.

In a previous paper [see Abstract 501 (1927)] the authors have discussed the solubility and rate of solution of oxygen in silver, and these results are now extended to the system hydrogen-silver. The solubility of hydrogen in silver has been investigated from 200° to 900° C. at pressures from 5 to 80 cm. The solubility first becomes appreciable at 400°, increases exponentially with increasing temperature, and is proportional to the square root of the pressure. A mechanism has been suggested for the absorption of gases by metals, and the connection between absorption, adsorption and diffusion is discussed. The diffusion of hydrogen through quartz has also been measured from 200° to 900° C., from which its mechanical nature has been confirmed. H. H. Ho.

1742. Kinetics of Coagulation. B. N. Desai. *Faraday Soc., Trans.* 24. *pp.* 181–195, *March*, 1928.

The velocity of coagulation of colloidal thorium oxide was measured by an optical method of great accuracy. The results showed that the constancy of the ratio T_k/T demanded by Smoluchowski's theory is maintained only up to a certain concentration of the coagulator. The results support the view that the coagulation process is autocatalytic. The region of slow coagulation was not observed. The difference in the value of K, the velocity constant, for corresponding concentrations of LiCl and KCl is explained as due to the influence of the ion carrying the same charge as the colloid. The theory of Freundlich for rapid as well as slow coagulation was confirmed and extended. F. J. B.

1743. Theory of the Ludwig-Soret Effect. M. Ballay. *Comptes Rendus*, 186. *pp.* 232–234, *Jan.* 23, 1928.

Van't Hoff's explanation, that the effect is due to the equality of osmotic pressure at two points of a column of solution heated to two different temperatures, is considered to be inaccurate. It is shown thermodynamically that at two points of a solution at different temperatures the ratio of the concentrations tends towards the value 1, whereas on van't Hoff's theory the ratio should be inversely as the absolute temperatures. Gravity may play a decisive role in experiments on this phenomenon, and the results may differ according to whether a vertical or a horizontal column is employed. L. M. C.

1744. Theory of the Soret Effect. E. D. Eastman. *Am. Chem. Soc., J.* 50. *pp.* 283–291, *Feb.*, 1928.

The thermodynamic properties of the entropy of transfer of dissolved substances was discussed. This quantity was considered in its relation to the effect on the solvent of the charge of the ions of the electrolytic solute. A comparison of indirectly determined entropies of transfer was made with measured Soret coefficients for certain substances. The results show that the Soret coefficients are best expressed when possible in terms of entropies of transfer. The solution of an electrolyte can be considered from the standpoint of the Soret effect as a two-component system in spite of the partial separation of the positive and negative ions in the temperature gradient. The Soret coefficients of the solute in imperfect solutions is finite at zero concentration, and nearly constant over a certain range from zero. There is a limited correspondence between the mobility of ions and their Soret coefficients. The Soret coefficient in solutions of non-polar substances is negligibly small, as is the irreversible Soret effect in all liquid solutions. [See Abstract 2146 (1926).] F. J. B.

1745. Determination of Dilute Salt Solutions by the Opacity of Fine Suspensions. A. Boutaric and G. Perreau. *Comptes Rendus*, 186. *pp.* 692–694, *March* 12, 1928.

Previous work by Cheneveau and Audubert [see Abstract 1041 (1921)] is referred to, and it is pointed out that the value of the determination of dilute salt solutions by measurements of the opacity or of the diffusive power of fine precipitates, is considerably lowered on account of the coalescence of the particles with consequent progressive increase of opacity. The present investigation is an attempt to increase the accuracy of the method by the addition of stable colloids, such as gum arabic, dextrine, amidon, and gelatine, to various suspensions. In the case of silver chloride, produced by additions of aqueous solutions of silver nitrate and potassium chloride, the error is found to be reduced. In many cases, however, the addition of colloids, instead of inhibiting the evolution of a precipitate, actually accelerates its formation. The results are claimed to be of interest for the study of protective colloids. H. H. Ho.

1746. Action of Water, Air, Oxygen and Carbon Dioxide on the Corrosion of Iron. K. Inamura. *Tohoku Univ., Sci. Reports,* 16. *pp.* 979–986, *Dec.,* 1927. *In English. Report No.* 174 *from the Research Inst. for Iron, Steel and other Metals.*

In this investigation the corrosion loss of iron caused by various kinds of water and a sodium chloride solution has been determined; also the action of air, oxygen and carbon dioxide on the corrosion of iron in pure water has been studied. It has been established that if there is a supply of oxygen alone, the corrosion of iron progresses even in the absence of carbon dioxide. The latter accelerates the rate of corrosion by oxygen, but not to as great an extent as is generally believed. H. H. Ho.

1747. Investigation of the Corrosion of Metals with a Thermobalance. K. Inamura. *Tohoku Univ., Sci. Reports,* 16. *pp.* 987–997, *Dec.,* 1927. *In English. Report No.* 165 *from the Research Inst. for Iron, Steel and other Metals.*

Honda's thermobalance [see Abstract 1 (1916)] has been used for this investigation, in which a commercial iron sheet was subjected to corrosion at 45° C. by seven reagents of various concentrations: H_2O, NaCl, Na_2CO_3, $NaHCO_3$, $NaNO_3$, Na_2SO_4, and KOH. Only the carbonate and bicarbonate solutions caused a continuous weight increase of the specimen through the adhesion of corrosion products which are not easily detachable. The weight decreased continuously in the other solutions. With $N/400$ H_2SO_4 continuous observation proved impossible on account of adhesion of hydrogen gas bubbles. In the case of $N/50$ Na_2CO_3 the weight of corrosion product corresponded mainly to ferrous hydroxide, which was admixed with a little ferric hydroxide. In general, the iron corrosion first occurs locally and gradually spreads over the whole surface. H. H. Ho.

1748. Corrosion of Copper and Brass. K. Inamura. *Tohoku Univ., Sci. Reports,* 16. *pp.* 999–1008, *Dec.,* 1927. *In English. Report No.* 176 *from the Research Inst. for Iron, Steel and other Metals.*

The corrosive action of the reagents below upon copper and brasses was examined over a period of five weeks and the order of corrosion loss found to be as follows:—

For copper: $NH_4Cl(N)$, HCl $(N/100)$, HNO_3 $(N/100)$, H_2SO_4 $(N/100)$, NaCl (N), NH_4OH $(N/100)$, NaCl $(N/100)$, NH_4Cl $(N/100)$, Na_2CO_3 $(N/100)$, H_2O, KOH $(N/100)$.

For 70 : 30 brass: $NH_4Cl(N)$, $HNO_3(N/100)$, $HCl(N/100)$, $H_2SO_4(N/100)$, $NaCl(N)$, $NH_4Cl(N/100)$, $NaCl(N/100)$, H_2O, $KOH(N/100)$, $NH_4OH(N/100)$, $Na_2CO_3(N/100)$.

For 60 : 40 brass: $HNO_3(N/100)$, $NH_4Cl(N)$, $H_2SO_4(N/100)$, $HCl(N/100)$, $NH_4Cl(N/100)$, $NaCl(N)$, $NaCl(N/100)$, H_2O, $KOH(N/100)$, $NH_4OH(N/100)$, $Na_2CO_3(N/100)$. H. H. Ho.

1749. Mechanism of Tempering of Carbon Steel. T. Matsushita and K. Nagasawa. *Tohoku Univ., Sci. Reports,* 16. *pp.* 901–913, *Dec.,* 1927. *In English.*

After the hardening of a carbon-steel rod by quenching, the tempering of the martensite, during reheating, takes place in two stages over the ranges 100°–170° C. and 170°–300° C. The changes are observed by an examination of (*a*) the magnetic properties, (*b*) the electrical resistance, (*c*) the thermal expansion. In these two transformations (tempering of α and β martensite) the carbon held in solution is precipitated as carbon, and not as cementite. On further heating (300°–400° C.) the carbon combines with some of the iron to form cementite. A. A. D.

1750. Anomalies of Annealing after Cold Hardening Copper and Brass. P. Nicolau. *Comptes Rendus,* 186. *pp.* 696–699, *March* 12, 1928.

Samples of annealed copper and brass have been tested by the static hardness test, in which the indent of a small metallic sphere under a constant force has been examined microscopically. Results are given which indicate the industrial importance of this procedure, particularly with respect to the study of temperature effects on annealing. H. H. Ho.

1751. Heat of Mixture of Molten Metals. M. Kawakami. *Tohoku Univ., Sci. Reports,* 16. *pp.* 915–935, Dec., 1927. *In English.*

Using three types of calorimeters, the heat of mixture for different systems of binary alloys has been measured. Sixteen systems have been examined, the mixing being effected at a temperature about 50° C. higher than that at which any solid component appears in the alloy. In the case of alloys having no intermetallic compound, this heat is negative, with the exception of some bismuth alloys. For alloys having one or more intermetallic compounds, the heat of mixture is positive, and is very large as compared with that in the last case. This fact confirms the view that an intermetallic compound existing in the solid phase does not decompose into its components during melting, but exists as such in the liquid phase. A. A. D.

1752. Heat of the A_2 and A_3 Transformations in Carbon Steels. S. Umino. *Tohoku Univ., Sci. Reports,* 16. *pp.* 1009–1030, *Dec.,* 1927. *In English.*

The heat content of electrolytic iron and a series of carbon steels has been measured by a calorimetric method over the range 680°–950° C. From the results both the mean and true specific heats are deduced. The A_2 change in pure iron (the magnetic transition) takes place over a range of about 130° C., the heat of transformation being 3·65 calories per gm. With increasing carbon content the heat associated with this change diminishes. The A_3 transformation (change in lattice) takes about seventeen minutes to complete itself at 930° C.; the associated heat is 5·35 calories per gm. The A_1 transformation (formation of eutectoid) is naturally absent in pure iron; for a carbon content of 0·77 % the associated heat is 13·60 calories per gm. A. A. D.

1753. Equilibrium Diagram of the Zinc-Antimony System. T. Takei. *Tohoku Univ., Sci. Reports,* 16. *pp.* 1031–1056, *Dec.,* 1927. *In English. Report No.* 177 *from the Research Inst. for Iron, Steel and other Metals.*

The diagram has been determined making use of (*a*) thermal analysis, (*b*) changes in electrical resistance, (*c*) thermal expansion. Three compounds occur, Zn_3Sb_2, Zn_4Sb_3, and ZnSb. The latter two are formed by a peritectic reaction, while the first crystallises directly from the melt. These compounds form solid solutions on both sides, and have polymorphic transformations—that is, the solid solution Zn_3Sb_1 changes at 455°–437° C. and 405° C., and the solid solution ZnSb at 492° C. The latter shows an interatomic change at 300° C. The correctness of the diagram has been confirmed by microscopic and X-ray examination. A. A. D.

1754. Theory of the Heusler Alloys. A. Kussmann and B. Scharnow. *Zeits. f. Phys.* 47. 11–12. *pp.* 770–785, 1928. *From the Reichsanstalt.*

The magnetic anomalies attendant on the ageing of the Heusler alloys have hitherto been explained on the Richarz theory according to which the elementary magnets, in consequence of their formation of complexes, experience an inhibition of their free directivity. The present authors now show the untenability of this theory by bringing forward physical and metallographical evidence for a transformation about 130° C., whose more or less completeness can account for the remarkable magnetic anomalies exhibited, since both phases possess different saturation values and Curie points. In addition, the extremely high coercitivity forces attendant on ageing may be explained as due to the volume contraction during the transformation and the internal tensions produced. H. H. Ho.

1755. Lead-Tin System of Alloys Re-Examined by an Electrical Resistance Method. F. H. Jeffery. *Faraday Soc., Trans.* 24. *pp.* 209–211; *Disc.*, 211–215, A*pril*, 1928.

A continuous method of recording change of electrical resistance as a function of the temperature by means of two Callendar recorders [see Abstract 443 (1928)], when applied to the lead-tin system, with due precautions to ensure the attainment of equilibrium, yields a diagram of the Roozeboom type 5, free from complication, for temperatures down to 75°. The boundaries of the solid solutions of tin in lead and of lead in tin are given, but no line of points at 149°, as indicated by Rosenhain and Tucker's results [see Abstract 322 (1909)], is observed. In the *Discussion*, the author's methods were criticised by **J. L. Haughton** and by **Rosenhain.** T. H. P.

1756. Budde Effect with a Mixture of Bromine Vapour and Air. E. Brown and D. L. Chapman. *Chem. Soc., J. pp.* 560–563, *March*, 1928.

Budde (*Pogg. Ann.* 144. p. 213, 1871) observed that chlorine expands on exposure to light, and suggested that the effect might be due to dissociation of chlorine molecules into atoms, but later he found that the expansion is accompanied by a rise in temperature of sufficient magnitude to account for the increase in volume. Several investigators have stated that dry chlorine does not exhibit the Budde effect, but the evidence is unconvincing. Recently, however, Ludlam (*Roy. Soc. Edin., Proc.* 44. p. 197, 1924) and Lewis and Rideal [see Abstract 1947 (1926)] have described experiments which appear to demonstrate conclusively that a dry mixture of pure bromine vapour and air does not expand when exposed to light. Using rather different experimental methods, with apparently reasonable precautions, results are now obtained which indicate that the Budde effect with a mixture of air and bromine is not diminished to any measurable extent by drying. T. H. P.

1757. Non-Appearance of the Recombination Luminescence in the Reaction between Alkali and Halogen Atoms. V. Kondratjew. *Nature*, 121. *pp.* 571–572, *April* 14, 1928.

From the possibility of a direct dissociation of salt molecules of NaCl type into the non-charged normal atoms by the action of light [see Franck, Kuhn and Rollefson, Abstract 2722 (1927)], there follows another possibility, namely, the direct recombination of the alkali and the halogen atoms in a salt molecule, followed by continuous light emission. All attempts to find this recombination spectrum having failed, it is suggested that the results of investigations on chemiluminescence may furnish the required mechanism of the building of the heteropolar molecules of the above type. From the results obtained by Polányi and his collaborators it may be assumed almost with certainty that the reaction between Na and Cl_2 in the gaseous phase follows the scheme: $Na + Cl_2 = NaCl + Cl$; $Cl + Na = NaCl^{\bullet}$; $NaCl^{\bullet} + Na = NaCl^{\bullet} + Na'$ and $Na' = Na + h\nu$. Here the exciter of the chemiluminescence is a molecule $NaCl^{\bullet}$ having an excess of energy, and the great intensity of the chemiluminescence suggests that the exciter ($NaCl^{\bullet}$) must exist for a sufficiently long time as an energy-rich molecule to meet a sodium atom. Such a long-living molecule could be a dipole $\overset{+}{Na}\overset{-}{Cl}$, which is formed by the recombination of the sodium and chlorine atoms and gradually loses its excessive energy of vibration by the emission of infra-red radiation quanta [see Abstract 482 (1928)]. An explanation is advanced of the way in which such recombination could occur. T. H. P.

1758. Dielectric Constant in Photochemical Reactions. K. G. Mathur, R. S. Gupta and S. S. Bhatnagar. *Indian Journ. Phys.* 2. *pp.* 243–255, *Jan.*, 1928.

Investigation of the photo-bromination of cinnamic acid and of the isomeric change of *o*-nitrobenzaldehyde into *o*-nitrosobenzoic acid in various solvents fails to reveal any such relationship between the velocity constants of the reactions and the dielectric constants of the media as appears in the photo-oxidation of iodoform and in the polymerisation of anthracene. [See Winther, Abstract 1940 (1926).] T. H. P.

1759. Photochemical Decomposition of Hydrogen Iodide: the Mode of Optical Dissociation. B. Lewis. *J. Phys. Chem.* 32. *pp.* 270–284, *Feb.*, 1928.

Measurements were made at pressures of HI of about 0·1 mm. Hg, at which calculations indicated that the probability of a collision taking place during the life of an excited HI molecule was small. A condensed zinc spark was used as light source, and one or other of the two strong bands at 2080 Å. and 2530 Å. were sent through the quartz reaction cell into a Moll thermopile. The cell was connected to a bifilar quartz fibre manometer, by means of which the pressure of the hydrogen produced from the HI was measured after the I and the remaining HI had been frozen out in an attached liquid-air trap. The average number of molecules decomposed per quantum in six experiments with λ2080 Å. was 2·36, and in four with λ2530 Å. 2·35, or about two, agreeing with Warburg's result for high

pressures where numerous collisions took place. It appears, then, that HI dissociates in an elementary act when radiation is absorbed, and that a collision of the excited molecule with another molecule is not necessary for the dissociation. A consideration of the energy relations in connection with the continuous absorption spectrum shows that the excited molecule dissociates into a normal H atom and an excited iodine atom in the metastable $2P_1$ state, the excess energy, if any, being dissipated as kinetic energy. The time between absorption and dissociation is shorter than 2×10^{-10} sec.
H. N. A.

1760. Gaseous Combustion at High Pressures. W. A. Bone, D. M. Newitt and C. M. Smith. *Roy. Soc., Proc.* 117. *pp.* 553–576, *Feb.* 1, 1928.

The "explosion limits" at room-temperature of hydrogen-air, methane-air and CO-air mixtures were determined from initial pressures of 1, 5, 10, 30, 50, 75 and 125 atmospheres, and those of CO-"helium-air" and CO-"argon-air" (*i.e.*, of mixtures of CO with an "air" composed of 20·9 % of oxygen and 79·1 % of helium or argon, respectively) were determined at initial pressures of 10 and 50 atmospheres. The results showed unmistakably that, whereas the general effect of increased pressure is to widen the "explosion limits" of either hydrogen-air or methane-air mixtures, those of CO-air mixtures are steadily narrowed thereby, and particularly so when the inert constituent of the "air" is nitrogen. It seems probable that at some very high initial pressure CO-air mixtures will become non-explosive at ordinary temperatures. This point will be investigated later.
A. W.

1761. Kinetics of the Combination of Hydrogen and Oxygen. C. N. Hinshelwood and H. W. Thompson. *Roy. Soc., Proc.* 118. *pp.* 170–183, *March* 1, 1928.

The authors examined by a static method the complete course of the combination of O and H at constant temperature and volume, over a range of temperature extending from the region of a purely catalytic surface reaction up as nearly as possible to the point where the combination ceases to be isothermal and passes into explosion. In the last 50° of this range a reaction comes into prominence which is quite different from the low-order heterogeneous reaction. It is of high but variable order, the influence of pressure being on the average approximately that corresponding to a reaction of the fourth order; it is strongly autocatalysed by steam, and has a high temperature coefficient. At high temperature the normal positive catalytic effect of the walls of the reaction chamber gives place to a negative effect, which may be due to the catalytic destruction of an autocatalyst for the principal reaction, or the interruption of "reaction-chains," or to both causes. It is concluded that the reaction measured is the true gas reaction between H and O. The numerical results obtained are given in tables and in graphical diagrams.
J. J. S.

1762. Effect of Catalysts on the Speed of Flame, Infra-Red Emission and Ionisation during the Combustion of Carbon Monoxide and Oxygen. W. E. Garner and C. H. Johnson. *Chem. Soc., J.* *pp.* 280–298, *Feb.*, 1928.

Describes the apparatus devised for making the measurements. The mixed gases were more thoroughly dried than was the case in previous experiments by the authors on the effect of catalysts [see Abstract 1462 (1927)], and this somewhat modified the results obtained with nitrogen peroxide. Substances containing hydrogen diminish the emission of infra-red radiation, and increase the flame speed and the magnitude of the ionisation. With a dry mixture two maxima of ionisation move past the electrodes as the flame passes; the second of these is frequently much larger than the first, particularly when carbon tetrachloride is present. Toward the end of the tubular bomb at the last electrode the ionisation persists from 0·1 to 0·2 sec. This is not due to reaction between CO and O_2, since the infra-red radiation is small after the flame has reached the fluorite window of the bomb. It may be caused by absorption of ultra-violet radiation by the hot gases behind the flame, the ions produced being relatively stable in the absence of water. The visible radiation observed by Ellis and Wheeler after the flame has passed may be due to the recombination of these ions. H. N. A.

1763. Influence of Temperature on the Formation of the Explosive Wave. P. Laffitte. *Comptes Rendus*, 186. *pp.* 951–953, *April* 2, 1928.

In a former paper (*Ann. de Phys.* 4, 1925, p. 639) the influence of temperature on the propagation of the explosive wave was studied, the gaseous mixture being fired by an electric spark in a tube at ordinary temperature, and then propagated in a heated tube. In the present research the influence of temperature on the *formation* of the wave is investigated. The mixture ($2H_2 + O_2$, or $CH_4 + 2O_2$) is fired in a tube heated from 15° to 350° C. It is found that the distance from the spark to the point where the explosive wave is established increases as the temperature is raised. For the mixture $CH_4 + 2O_2$ the distance increases from 55 cm. at 15° C. to 90 cm. at 300° C., while at 340° to 360° C. no explosive wave is formed in a tube 100 cm. long. Photographs are given illustrating these results; and it is observed that elevation of temperature produces the same effect as a dilution of the mixture by an inert gas. T. B.

1764. Cataphoresis and Charge. H. R. Kruyt and P. C. van der Willigen. *Zeits. f. phys. Chem.* 130. *pp.* 170–176, *Oct.*, 1927.

The importance of the charge on the particles for the stability of colloids has been known for years in the case of lyophobe colloids, and it has recently been shown to be of great importance for lyophile colloids. The usual method for its estimation is by cataphoresis experiments, but the p.d. at various interfaces can also be measured by electro endosmosis and streaming potential. By means of Burton's method, the cataphoresis velocity of selenium, arsenic trisulphide, and mercuric sulphide sols have been determined in the presence of different electrolytes, and it is found that the velocity is raised by the addition of univalent ions, but decreased by polyvalent ions. The results are discussed from the standpoint of the usual equations for cataphoresis, but it is pointed out that as the potential of the double layer ζ is raised, ν, the velocity of cataphoresis, and ζ are not necessarily proportional. On the other hand, since the d.c. of the medium rises with the salt concentration, ζ falls, although ν increases. The results of the investigation are not altogether in accord with the Powis theory of the critical potential. L. M. C.

1765. Haber's Glass Cell. W. S. Hughes. *Chem. Soc., J. pp.* 491–506, *Feb.*, 1928.

Glass for use in Haber's glass cell (*Zeits. phys. Chem.* 67. p. 385, 1909) should be as free from potash, alumina, and borates as possible, and the bulb should be blown rapidly to avoid devitrification. Glass with 72 % of SiO_2, 8 of CaO and 20 of Na_2O is satisfactory, and in acid solution gives no evidence of the mixed electrode function of Horovitz [see Abstract 2335 (1923)] and Schiller [see Abstract 2371 (1924)]. Its behaviour is best explained by the hypothesis that the hydrogen-ion concentration is maintained relatively constant within the glass phase by the buffer action of the sodium acid silicate in the glass. This buffer action begins to become less effective at about *p*H 9, which is about the value for a sodium acid silicate mixture half neutralised with respect to the first hydrogen ion of silicic acid. In contact with a solution more alkaline than *p*H 13, the glass surface is rapidly attacked. Here neutralisation of the second hydrogen ion of silicic acid begins, and the attack is accompanied by a rapid fall of the hydrogen-ion concentration within the glass, and by a corresponding drop in the e.m.f. of the glass cell. Sodium and lithium hydroxides show this effect more than potassium hydroxides, probably because they penetrate the glass the more readily owing to the smaller dimension of the ions. Measurement of the *p*H of half-neutralised buffer mixtures gives the following dissociation constants: the second-stage constants of arsenic and chromic acids, $8\cdot3 \times 10^{-8}$ and $1\cdot0 \times 10^{-7}$ respectively; the first-stage constant of arsenious acid, 6×10^{-10}; azoimide, $2\cdot56 \times 10^{-5}$, and hydrazine hydrate, $1\cdot4 \times 10^{-6}$. Measurement of the hydrogen-ion activity of copper sulphate solutions shows that the hydrolysis of this salt is a slow reaction at ordinary temperatures, and that the basic sulphate precipitated by alkali has the composition $3CuO, CuSO_4, xH_2O$. The *p*H of an iodide-iodate mixture is about 6·9 after two-thirds of the iodate has been decomposed by addition of hydrochloric acid. T. H. P.

1766. Silver Nitrate Concentration Cells in Acetonitrile and Benzonitrile. F. K. V. Koch. *Chem. Soc., J. pp.* 524–527, *Feb.*, 1928.

Measurements of the e.m.f. of silver nitrate concentration cells in acetonitrile and benzonitrile at 0° and 25° give results which support the Nernst formula for such cells, and show that the laws of solution are obeyed by these solvents at least as closely as by water. The values obtained for the transport number of the silver ion in acetonitrile agree well with those of Schlundt (*J. Phys. Chem.* 6. p. 189, 1903), and are nearly the same as the values for benzonitrile, support being thus furnished to the view that the transport number of an ion in a given salt should be independent of the solvent. T. H. P.

1767. Electrolytic Capacitance of Platinum-Sulphuric Acid Cells. W. M. Pierce. *Phys. Rev.* 31. *pp.* 470–475, *March*, 1928.

An electrolytic cell containing platinum electrodes in a solution of sulphuric acid had its electrolytic capacitance determined by a new d.c. method, which consists essentially in observing the current-time record when a small, constant potential is impressed on the circuit containing the cell. The method is described and is used to ascertain whether the capacitance of the cell is a function of the time constant of the circuit in which it is placed. The results show that the capacitance is not a function of the time constant. Alternating and direct-current measurements were made on the same cell. The a.c. observations are shown to group with those of others under the general relation $C\omega^n = A$, C being capacitance, ω the angular frequency ($\omega = 2\pi f$), and A a constant. The value of n is shown to vary with the frequency, thus necessitating a modification in the Warburg theory of electrolytic capacitance, which demands that n be 0·5. An empirical relation of the form $(\omega + \omega_0)(C - C_0) = D$ is found, connecting the capacitance of the cell with the frequency of the current flowing through it. The relation fits the combined set of a.c. and d.c. observations very closely. AUTHOR.

1768. Theory of the Galvanic Cell. N. Isgarischew. *Zeits. f. Elektrochem.* 34. *pp.* 128–129, *March*, 1928.

On the basis of the hydrate theory of solutions [see Abstract 2743 (1926)], an approximate calculation is made of the magnitude of ϵ for various galvanic cells. Agreement between the calculated values and the experimental value for zinc is not perfect, but, taking the data as a whole, the conclusion is reached that the representation of the mechanism of the action of these cells by the hydration theory rests on a real foundation. Possibly a more exact determination of the magnitudes required for the calculation of ϵ may result in better agreement with the experimental values. T. H. P.

1769. Variation of the Electromotive Force in a Photoactive Cell Containing a Fluorescent Electrolyte with the Intensity of Illumination. W. Rule. *Nat. Acad. Sci., Proc.* 14. *pp.* 272–278, *March*, 1928.

The e.m.f. of a photoactive cell, comprising platinum electrodes immersed in an aqueous solution containing 0·05 grm. of fluorescein and 10 grm. caustic potash per litre, is shown to vary with the time and intensity of illumination of one of the electrodes in such manner as to indicate that the e.m.f. originates largely in a photochemical modification of the fluorescent electrolyte. J. S. G. T.

1770. Modifications of the Sand Auxiliary Electrode. T. B. Smith. *Faraday Soc., Trans.* 24. *pp.* 216–225; *Disc.*, 233–235, *April*, 1928.

By the use of a porous diaphragm in place of the special tap of the Sand electrode [see Abstract 932 (1907)], and by modifying the design of the tube, it is found possible to reduce the working resistance of the auxiliary electrode to about one-tenth of the usual value. This enables the potentiometer voltmeter to function also as a null point detector without causing any appreciable error on account of concentration polarisation of the half-cell. A second modification is described in which the use of either taps or diaphragms in the electrical circuit is avoided. It has about the same resistance as the first pattern, but permits of the use of connecting liquids of higher conductivity than usual. This brings the null point detection within the range of a voltmeter of relatively low sensitivity. For most purposes this modification is to be preferred, but the diaphragm pattern has the advantage that it may be used for a considerable time without refilling with electrolyte. The employment of a voltmeter for the detection of the null point is more convenient than that of a capillary electrometer, and the cost of the latter is saved. The second modification may conveniently be used as a quinhydrone electrode, the use of which has been shown to be effective in the control of bismuth determinations. Arrangements are described for utilising and, where necessary, modifying panel-mounting radio apparatus so as to permit of the enclosure of the parts most vulnerable to attack by acid fumes. T. H. P.

1771. Overpotential at Metallic Kathodes. Silver in Neutral and Alkaline Solutions. J. Grant. *Faraday Soc., Trans.* **24.** *pp.* **225–233;** *Disc.*, **233–235,** *April,* **1928.**

Investigation of the overpotential of a silver kathode in a number of neutral and alkaline solutions shows that the overvoltage increases rapidly with the duration of the electrolysis up to a certain point, and then remains constant. The time taken to arrive at this point decreases as the electrolytes approach the neutral point. The overvoltage as measured by the direct method increases rapidly with the current density, and the curves connecting these two magnitudes show a point of inflexion or change of direction at a certain point, which is close to the values of the overvoltages obtained by the "commutator" method; the latter values increase rapidly with the current density up to a certain point and then remain constant. The decay curves of polarisation sink to a value which remains nearly constant over a considerable time and which usually approximates to those obtained by the above method. A linear connection between the *p*H voltage and the overvoltage of the solution is indicated graphically, the deviations being possibly due to secondary influences yet to be investigated. Considerations based on the buffer actions of the various solutions and on the effect of an insoluble layer on the electrode fail to account completely for the deviations, but the possibility of compensating influences cannot be ignored. Investigations of the conditions of the formation of a black deposit on the silver, and the effect of this on the overvoltages give results which are, in general, analogous to those already obtained with an antimony kathode in neutral and alkaline solutions. T. H. P.

1772. Hydrogen Overvoltage and Reduction of Oxalic Acid at Mercury Kathodes. P. Herasymenko. *Zeits. f. Elektrochem.* **34.** *pp.* **129–136,** *March,* **1928.**

The dependency of the kathode potential of the liberation of hydrogen at mercury electrodes on the hydrogen-ion concentration is expressed by the equation, $\pi = \frac{2RT}{F} lg[H^+] + k$. Heyrovský's theory of overvoltage [see Abstract 2639 (1924)] explains this behaviour of the kathode potentials on the assumption that the reactions at the kathode follow the course, $H^+ + \epsilon \rightarrow H$, $H + \epsilon \rightarrow H'$, $H^+ + H' \rightarrow H_2$, so that the separation of hydrogen is accelerated (catalysed) by the hydrogen ions in the solution. The kathode potential increases by about + 0·003 volt for a rise in temperature of 1°, this high temperature coefficient being attributed to increased catalytic activity of the hydrogen ions. In contradiction to Möller's view [see Abstract 1016 (1908)], the overvoltage at mercury electrodes exhibits no maximum between − 4° and 100°. At all temperatures employed, the current intensity varies with the kathode potential according to the formula $i = k[H^+]^{\frac{4}{3}} e^{-\frac{2\pi F}{3RT}}$, from which it follows that the current intensity must be proportional to the surface concentrations of the participants in the reaction, that is, $i = k[H]^{\frac{2}{3}}[H^+]^{\frac{2}{3}}$. Analysis of the reduction potentials of oxalic acid solutions of various concentrations shows that the mechanism of the reduction of this acid at mercury kathodes is closely connected with the hydrogen overvoltage; the current-potential curves are identical with those of hydrogen formation. On the assumptions that undissociated oxalic acid forms the complex $H^+(C_2O_4H_2)_4$ with hydrogen ions and that the velocity of reduction of oxalic acid (current intensity) is proportional to the surface concentration of negative hydrogens (H′) and oxalic acid complexes, the kathode potential of the reduction of oxalic acid is expressed by $\pi = \frac{RT}{F} lg[H^+]^2[\dot{O}]^{2 \cdot 4} + \pi_0$. The "normal" reduction potential (π_0) of oxalic acid is $- 0 \cdot 606 \pm 0 \cdot 007$ volt. T. H. P.

1773. Potential Difference of Dilute Solutions. M. Planck. *Preuss. Akad. Wiss. Berlin, Ber.* **34.** *pp.* 285–288, 1927.

Büchi's statement [see Abstract 224 (1925)] that for diffusion cells containing hydrogen chloride and potassium chloride the Henderson formula for the e.m.f. developed is much more accurate than that deduced by Planck is criticised, the conditions of Büchi's measurement not being in accord with the assumptions on which the author's formula is based [see Abstract 1105 (1928)]. T. H. P.

1774. Solution Tension of Silver in Solvents other than Water. F. K. V. Koch. *Chem. Soc., J. pp.* 269–280, *Feb.*, 1928.

To investigate the effect of the solvent on the solution tension (or electrode potential), it is advisable to select an electrode which will give constant and reproducible potentials, is a primary electrode, has only one valency, and has a corresponding salt soluble in many solvents. These conditions are fulfilled by the electrode $Ag/AgNO_3$. Measurements at room-temperature show that the solution tension of silver is definitely greater in pyridine, aniline, and acetonitrile than in water, a relationship which is in conflict with the formulation of Baur and others. There is, indeed, no evident connection between the solution tension (or normal potential) and the dielectric constant of the solvent. An explanation of the above results is sought in the action of specific attractive forces between the metal ion and the solvent molecule. Molecules containing groups of ammoniacal or nitrile character are shown to have, in general, a greater affinity for the silver ion than those containing hydroxylic or ketonic groups. T. H. P.

1775. Activity Coefficients of Aqueous Nitric Acid. E. Abel, O. Redlich and B. v. Lengyel. *Zeits. f. phys. Chem.* **132.** 3–4. *pp.* 189–207, *March*, 1928.

A series of experiments are described for the determination of the freezing temperatures of aqueous solutions to an accuracy of at least 0·0002° for dilute and less than 0·1 % for concentrated solutions. This accuracy has been attained through differential measurements by means of thermo-elements (thirty junctions) between Dewar vessels. From measurements of aqueous nitric solutions up to a molar content of about 4 mol. per 1000 g. water, the activities of both components, the activity coefficients, and the free energies of dilution have been calculated.

H. H. Ho.

1776. Dissociation Constant of Acetic Acid and the Activity Coefficients of the Ions in Certain Acetate Solutions. E. J. Cohn, F. F. Heyroth and Miriam F. Menkin. *Am. Chem. Soc., J.* **50.** *pp.* 696–714, *March*, 1928.

Investigation of the dissociation of acetic acid in presence of its sodium salt, and consideration of interionic forces by combining the mass law expression for the dissociation of a weak acid with the Debye-Hückel equation for the activity coefficient of an ion give for acetic acid

$$p_{\mathrm{H}} + -\log\,[(\mathrm{CH_3CO_2^-})/(\mathrm{CH^3CO_2H})] = \mathrm{P}_{\mathrm{K}}^{-} - 0\cdot 5\sqrt{\mu}/(1+kb) + \mathrm{K}s\mu = \mathrm{P}_{\mathrm{K}'}.$$

Exact measurements may be made with the hydrogen electrode on buffer solutions of relatively high molecular concentration, but such low ionic strength that specific ion effects are almost eliminated; in such circumstances the dissociation constant of the acid may be accurately determined by extrapolation. Taking 0·3380 volt for the 0·1 N calomel electrode, such data give for acetic acid $\mathrm{P_K} = 4\cdot 73$; $\mathrm{K}a = 1\cdot 86 \times 10^{-5}$, which agrees with Kendall's estimate of $1\cdot 85 \times 10^{-5}$ from conductivity measurements [see Abstract 1781 (1921)]. Measurements made of the e.m.f. give the dissociation constant of acetic acid with an accuracy of more than 0·6 millivolts, so that the value assumed for the 0·1 N calomel electrode thus becomes the controlling factor in determining the dissociation constant of acetic acid by this method. If 0·3357 is taken for the 0·1 N calomel electrode, these data yield $\mathrm{P_K} = 4\cdot 77$; $\mathrm{K}a = 1\cdot 7 \times 10^{-5}$, and certain of the results are more consistent when calculated by means of this value. From both theoretical and practical considerations the accumulating data render it desirable to employ a value for the 0·1 N calomel electrode other than 0·3380, and thus to increase the entire $\mathrm{P_H}$ scale, and it is suggested that the comparison of e.m.f. measurements of the kind here presented, with conductivity measurements on the same weak acid and its salts, corrected for interionic forces, could form the basis for comparison. The activity coefficients estimated for the acetate anion are independent of any assumption regarding the calomel electrode, and values of the salting-out constant, Ks, and of b, are estimated for solutions varying in concentration from 0·02 to 4 M, and in the mole fraction as $\mathrm{CH_3CO_2Na}$ from 0·1 to 0·9. Tables and graphs are given to facilitate the preparation of buffer solutions of the same ionic strength and varying $\mathrm{P_H}$, or *vice versa*.

T. H. P.

1777. Electrodeposition of Indium with the Dropping Mercury Kathode. S. Takagi. *Chem. Soc., J. pp.* 301–306, *Feb.*, 1928.

The precipitation of indium from solutions of indium trichloride at the dropping mercury kathode was found to take place in conformity with the Nernst logarithmic equation. The normal deposition potential of indium from a solution of indium trichloride in 0·1 N. HCl, was found to be − 0·500 volt, when referred to the normal calomel electrode. The deposition potential was found to depend upon the concentration of the hydrochloric acid. Sulphate ions prevent the appearance of the turning-point in the polarisation curve. This is probably due to the removal of indium ions as a basic salt. The method was applied to the detection of indium in metallic zinc and gallium. The minimum concentration of indium chloride that can be detected by this method was found to be 10 mol. per litre. It was not possible to determine the deposition potential of gallium in acid solutions.

F. J. B.

1778. Theory of Electrolytic Deposition of Chromium from Aqueous Solutions of Chromic Acid. V. Schischkin and Helen Gernet. *Zeits. f. Elektrochem.* 34. *pp.* 57–62, *Feb.*, 1928.

The deposition of chromium from a solution containing 250 gm. $\mathrm{CrO_3}$

and 2 gm. of SO_4 per litre, in which the ratio $\overset{++}{\mathrm{Cr}}$: $\overset{+++}{\mathrm{Cr}}$ was about 1 : 35, was studied by a microscopical examination of the deposited metal. The deposits, both the bright and matt, were found to be imperfect, owing to lines and gas bubbles in the deposit, as well as the tendency of the deposit to grow into rough grains. At temperatures higher than 40° C. the matt deposit became rough and crystalline as the current density was raised. The current yield of the metal showed a marked increase when the deposit became matt. At current densities less than that required to produce a bright deposit at a definite temperature, a thin deposit was obtained which became opalescent at higher temperatures. The mechanism of the reactions involved in the deposition of chromium was discussed in the light of these results. F. J. B.

1779. Influence of Pressure on the Decomposition Voltage of Water at Constant Temperature. C. F. Holmboe. *Zeits. f. Elektrochem.* 34. *pp.* 67–68, *Feb.*, 1928.

A solution of sodium hydrate of specific gravity 1·16 at 18° C. was electrolysed in a steel vessel under pressures varying from atmospheric pressure to 100 atmospheres. The temperature was maintained at 19·1° C. It was found that the decomposition potential was independent of the pressure, within the range of pressures used in the experiments.

F. J. B.

1780. Electrolysis of Water by an Alternating Current. Canaud. *Comptes Rendus*, 186. *pp.* 688–690, *March* 12, 1928.

When an alternating current of 50 periods at 120 volts is passed through water between iron electrodes maintained at such a distance apart that the current density is about 5 amperes, a rapid rise of temperature occurs with abundant evolution of gas. The varying gas compositions under a graduated series of experimental conditions are recorded. It is found that after the electrodes have attained a steady state the average volume of hydrogen disengaged is about 1/350 of the volume given by the corresponding direct current. H. H. Ho.

1781. Electrochemical Behaviour of Acetylene. R. Mueller and H. Kumpfmiller. *Zeits. f. Elektrochem.* 34. *pp.* 70–74, *Feb.*, 1928.

The behaviour of acetylene in solution in dry acetone as regards electrical conductivity, electrode potential, and reactions at the electrodes was investigated. The solubility of acetylene in dry acetone was determined at 18° C. and 25° C. The conductivity showed a minimum when the concentration of the acetylene was one molecular weight in seven litres. The conductivity at infinite dilution was found by extrapolation to be 0·0143. Measurements of the electromotive force of the hydrogen and carbon dioxide electrodes in acetylene solutions were made, and the quinhydrone and the calomel electrodes were used as comparisons. Electrolysis of solutions of acetylene in acetone was carried out in a special form of apparatus, by means of which it was possible to measure the kathode and anode potentials. The decomposition potential varied between 1 and 2·5 volts, owing to secondary reactions using up the products. After electrolysis at 300 volts for three weeks the acetone was removed by distillation, and a small amount of brown, viscous liquid, similar to the distillation products of rubber, was obtained. The yield was too small to warrant further investigation. F. J. B.

1782. Electrolysis of Benzoic Acid. E. Bauer and E. Müller. *Zeits. f. Elektrochem.* 34. *pp.* 98–103, *Feb.*, 1928.

The electrolysis of aromatic acids containing the carboxyl group COOH is of the type of a reduction of CO_2 to CO and formaldehyde H_2CO. Thus $C_6H_5 . COOH = C_6H_6 + CO_2$; $C_6H_5 . COH = C_6H_6 + CO$; $C_6H_5 . CH_2OH = C_6H_6 + C_2HO$. Following Mettler, the authors electrolyse aqueous alcoholic solutions of benzoic acid containing sulphuric acid in a diaphragm cell with freshly-prepared lead kathodes. The kathode gas of the electrolytic reduction consisted of benzene, CO_2, a little CO, traces of formaldehyde and an oil, probably cyclohexenone, but no benzylalcohol; the kathode became black with a carbon film. The anode gas of the oxidation consisted also of benzene, CO_2, and CO; CO and benzaldehyde first formed from the primary benzoylperoxide were probably oxidised subsequently.
H. B.

1783. Electrochemical Preparation of Berlin Blue. B. Ormont. *Zeits. f. Elektrochem.* 34. *pp.* 106–111, *March*, 1928.

When solutions of potassium ferrocyanide were electrolysed, using iron electrodes, Berlin blue was obtained. A series of experiments were made on the electrolysis of solutions containing potassium ferrocyanide, together with sodium sulphate and sodium chloride. The kathode was separated by a diaphragm. It was found that in the presence of sodium chloride the yield reached 100 %. At the anode a white or bluish white precipitate was obtained, which soon became dark blue. In the presence of sodium sulphate or sodium nitrate, oxygen was evolved in consequence of the passivity of the iron, and the ferrocyanide ions were converted into ferricyanide ions. The current yield increased with increase of temperature up to 70° C., and the energy consumption decreased to 1·5 kilowatt-hours per kilogramme of product. Sodium sulphate and sodium chloride have no material effect on the course of the electrolysis. Current densities up to 100 amperes per square decimetre can be employed. F. J. B.

1784. Electrolytic Disintegration of Glass. P. Selényi. *Ann. d. Physik*, 85. 5. *pp.* 643–644, *March* 19, 1928.

In the case of an insoluble anode the expected evolution of oxygen in the electrolysis of glass was qualitatively shown by means of an ordinary vacuum lamp. In a previous paper [see Abstract 1099 (1928)] the author gave an account of this. In the present note he describes a quantitative determination of the development of oxygen when glass is electrolytically decomposed. J. J. S.

1785. Hg as an Electrolyte. G. Neidl. *Zeits. f. tech. Phys.* 9. 2. *pp.* 76–77, 1928.

Forgotten observations (Schweigger 1824, Herschel 1826) on movements of H between electrodes again taken up. It is found that there is a discharge of negative Hg ions, forming a negatively-charged vapour.
A. D.